## **VOLUME I OF II**

## ENERGY SAVINGS OPPORTUNITY SURVEY FORT GILLEM, GEORGIA

Prepared for

SAVANNAH DISTRICT CORPS OF ENGINEERS SAVANNAH, GEORGIA

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## LIST OF ABBREVIATIONS

ACH - air changes per hour

AAFES - Army Air Force Exchange Service

AHU - air handling unit

Bldg - building

cfm - cubic feet per minute

conf. - confirmation

DCU - digital control unit
DDC - direct digital control

DEH - Director of Engineering and Housing

DHW - domestic hot water
DX - direct expansion

ECIP - Energy Conservation Investment Program

ECO(s) - Energy Conservation Opportunity(ies)

ESOS - energy savings opportunity survey

F - Fahrenheit FCU - fan coil unit

ft - foot, feet FY - fiscal year

gpm - gallons per minute

hp - horsepower

HPS - high pressure sodium

hr - hour(s)

HW - hot water
in. - inch(es)

kVar - kilovolt amp reactive

kW - kilowatt, one thousand watts

kWh - kilowatt-hour, one thousand watthours

LAPS - lighting automation panels

LBH - pounds per hour lbm - pounds mass

LCCID - Life Cycle Cost in Design

MBtu - British thermal units (thousand)

mcf - thousand cubic feet

## LIST OF ABBREVIATIONS

(Continued)

Military Construction Army Program MCA Military Construction Program MCP NAF non-appropriated funds PRV pressure reducing valve pounds per square inch, absolute psia pounds per square inch, gauge psig Quick Return on Investment Program QRIP RCU remote control unit revolutions per minute rpm **Shared Energy Savings** SES supervision, inspection, and overhead SIOH SIR Savings-to-Investment Ratio Scope of Work SOW 100,000 Btus therm utility control system UCS **UPW** uniform present worth

## **COMMANDER SUMMARY**

### PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

## **RESULTS**

Of the individual ECOs evaluated, 12 ECOs had a savings-to-investment (SIR) ratio greater than 1.0. Those ECOs having an SIR greater than 1.0 are, by definition, economically feasible. The total estimated construction cost for the 12 ECOs is \$4,455,080.

The individual ECOs were grouped into projects for possible funding under three main funding areas: 1) Military Construction Army (MCA) program; 2) Low-cost, No-cost projects; and 3) Non-Appropriated Funds (NAF) projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1 Included the following ECOs:
  - ECO 1, Add duct insulation
  - ECO 1, Add roof insulation
  - ECO 5, Install high efficiency electric motors
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 14, Provide infrared heaters
  - ECO 15, Separate (automatic) light switches
  - ECO 18, Replace exit sign bulbs with fluorescent bulb kits
- MCA Project 2 ECO 19, Previous lighting study review, for light fixture replacement

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low-cost, no-cost ECO to be performed by in-house maintenance staff.

Two ECOs were evaluated for NAF facilities funding:

- ECO 14, loading dock seals
- ECO 18, replace exit sign bulbs with fluorescent bulb kits

Table 1 on the following page summarizes the savings, costs, and project economics of the proposed projects. It is recommended the Army fund and implement construction of the energy conservation projects to lower facility utility consumption in order to meet the energy reduction goals of Executive Order 12759 of April 17, 1991.

TABLE 1 ECONOMIC PROJECT SUMMARY

					7,	
SIMPLE PAYBACK (yrs)	11.4	11.5	0.9	5.0	6.3	10.6
SIR	1.1	1.3	13.5	4.5	2.5	1.6
CONST COST (\$)	735,360	2,380,795	925	102,705	12,711	3,526,544
TOTAL COST AVOID (\$)	64,418	206,159	1,010	20,433	2,028	294,048
NON- ENERGY SAVINGS (\$)	(433)	0	550	0	(906)	(286)
ANNUAL DEMAND CREDIT (\$)	8,843	130,378	0	0	924	140,145
ANNUAL ENERGY SAVINGS (\$)	26,008	75,781	460	20,433	2,010	179,358
TOTAL ENERGY SAVINGS (MBtu)	9,994	10,134	66	4,170	592	24,666
ANNUAL GAS SAVINGS (MBtu)	6,671	0	66	3,829	0	10,599
ANNUAL ELECTRIC SAVINGS (RWh)	974,092	2,971,800	0	100,073	78,840	4,124,805
ANNUAL DEMAND SAVINGS (kW)	98	1,270	0	0	6	1,356
ECO NO.	MCA Project 1	MCA Project 2	Low-Cost/ No-Cost ECO	NAF ECO-14 Seals	NAF ECO-18	TOTAL

## **EXECUTIVE SUMMARY**

## PURPOSE OF STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the Corps of Engineers, Savannah District, in September 1991. The study analyzes energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

### ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table ES-1 on page ES-2.

During the entrance interview conference, ECO 18 was included. ECO 18, which converts incandescent exit sign light bulbs to fluorescent bulbs, was evaluated for all buildings specified for ECO 15, lighting controls.

Based on discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated, are included in Table ES-2 on page ES-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

Table ES-3 on page ES-4 contains a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

## TABLE ES-1 ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

## TABLE ES-2 NONFEASIBLE ECOs

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
207	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
400	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
401	5	No motors 1 horsepower or larger
401	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
403	5	No motors 1 horsepower or larger
701-710, 198, 922, 923, 942	All ECOs	Buildings scheduled for demolition

TABLE ES-3
BUILDING-ECO MATRIX

DESCRIPTION         1         2         3         4         5         6         7         8         9         10         11           Administration         A </th <th></th> <th>12 13 14 15 16 17 18 19 19 I</th> <th>A A* A A A* A*</th> <th>A A*</th> <th>A A A* A*</th> <th>A A*</th> <th>A A A A* A*</th> <th>A A A*</th> <th>A A*</th> <th>A A*</th> <th>A A A A* A*</th> <th>N A A A* A*</th> <th>A A A A*</th> <th>A A A*</th> <th></th> <th>A A A*</th> <th>V V</th> <th><b>V V V</b></th>		12 13 14 15 16 17 18 19 19 I	A A* A A A* A*	A A*	A A A* A*	A A*	A A A A* A*	A A A*	A A*	A A*	A A A A* A*	N A A A* A*	A A A A*	A A A*		A A A*	V V	<b>V V V</b>
DESCRIPTION         1         2         3         4         5         6         7         8           Administration         A <td>BER</td> <td>11</td> <td></td>	BER	11																
DESCRIPTION         1         2         3         4         5         6         7         8           Administration         A <td>NUM</td> <td>10</td> <td></td> <td>Α</td> <td></td> <td></td> <td>Α</td> <td></td> <td>Α</td> <td></td> <td>A</td> <td>V</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	NUM	10		Α			Α		Α		A	V						
DESCRIPTION         1         2         3         4         5         6         7           Administration         A <td>ECO</td> <td>6</td> <td>V</td> <td></td> <td></td> <td>А</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>_</td> <td></td> <td></td>	ECO	6	V			А										_		
DESCRIPTION         1         2         3         4         5         6           Administration         A <td></td> <td>8</td> <td></td>		8																
DESCRIPTION         1         2         3         4         5           Administration         A         A         A         A         A           Maintenance         A         A         A         A         A           Fire Station         A         A         A         A         A           Officers Club         A         A         A         A         A         A           Storage         A*         A*         A*         A         A         A         A           CID Building         A	<u>}</u>	7	V					,								_	_	
DESCRIPTION           Administration         A         A         A         A           Maintenance         A         A         A         A           Fire Station         A         A         A         A           Officers Club         A*         A*         A         A           Storage         A*         A*         A         A           CID Building         A         A         A         A           Storage         A*         A*         A         A           BOL         BOL         A         A         A           Bining Facility         A         A         A           Storage         A         A         A           Storage         A         A         A		9	<											<u></u>	_			
DESCRIPTION  Administration A A A Maintenance Fire Station Officers Club Storage CID Building Commissary Storage DOL Eighty-first Arc. Dining Facility Storage Storage Storage Storage Storage Storage		5	V	⋖	<	V	4	V	A	٧	¥	z	z	⋖		_	_	
DESCRIPTION  Administration A A  Maintenance Fire Station Officers Club Storage Commissary Commissary Storage DOL Eighty-first Arc. Dining Facility Storage Storage Storage Storage Storage Storage		4	⋖	A	⋖	4	<	<	A	V	⋖	⋖	<	<				
DESCRIPTION  Administration A Maintenance Fire Station Officers Club Storage Commissary Commissary Storage DOL Eighty-first Arc. Dining Facility Storage Storage		3	V				*V											
DESCRIPTION Administration Maintenance Fire Station Officers Club Storage CID Building Commissary Storage DOL Eighty-first Arc. Dining Facility Storage		2	V				*A											
A Z H O S O O S D H D S S		1	4				<b>A</b> *											
BLDG # 101 103 103 207 207 207 207 400 400 403 505	-			+-	+-	133 Officers Club	+-	213 CID Building	214 Commissary	308 Storage	+	┿	+	+	+-		+	

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A\* - Added as an applicable project

# TABLE ES-3 BUILDING-ECO MATRIX

	19	A*	A*	<b>A</b> *	*A	*A	A*	*W
	18			<b>A</b> *				**
	17	V	V		V	4		
	16	A	V	A	A	V	٧	<
	15			Α				٧
	14			A				
	13							
	12							
BER	11							•
ECO NUMBER	10			Α				
ECO	6							
	8							<b>A</b> *
	7							
	9							
	5			Α			Α	A
	4			A			A	A
	3			V			Α	
	2			Α			Α	
	1			A			A	
DESCRIPTION		510 Storage	511 Storage	Storage {1}	Storage	Storage	Theater (T)	Fitness Center
BLDG	#	510	511	512	513	514	735	935

{1} Representative of Buildings 505 through 514

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A\* - Added as an applicable project

## **RESULTS**

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table ES-5 on page ES-9). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 12 projects is \$4,455,080.

Table ES-4 on page ES-7 lists the economic summary of each individual ECO, in ECO number order. Table ES-5 on page ES-9 lists the economic summary of each individual ECO, in order by SIR.

All ECOs determined to have an SIR less than 1.0 should be dropped from further analysis. These include:

- ECO 1, Pipe Insulation
- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 3, Weatherstripping and Caulking
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

TABLE ES-4 ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

1-Wall Insulation	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (KWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
- September		NO BUILDINGS WI	GS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
Istiation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDINGS WI	GS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
2-Insulate Windows	-	NO BUILDINGS W		TH SIR GREATER THAN 1.0	HAN 1.0						
3-Caulking		NO BUILDINGS WI	GS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
4-HW Temp		NOT APPLICABLE		- MEASUREMENT ONLY	NLY						
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDINGS W	GS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	66	99	460	0	550	1,010	925	13.5	0.9
9-Heat Reclaim		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
10-Air Stratification		NO BUILDINGS W	GS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	22	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NIGTIME ON	NO BUILDINGS WITH SIR	GREATER THAN 1.0	HAN 1.0			,			
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2

TABLE ES-4
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

				(CONC	(CONCLUDED)						
ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (KWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
16-Demand		NOT APPLICABLE	ABLE								
17-Boiler		NOT APPLICABLE	ABLE								
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

TABLE ES-5 ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

BCO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (KWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	66	66	460	0	550	1,010	925	13.5	6:0
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	22	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	41	126	0	174	300	2,682	1.7	8.9
14-IR Heaters	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	2,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
	1,365	5,637,596	26,527	45,757	267,791	140,145	(696)	406,773	4,452,398		
4-HW Temp		NOT APPLICABLE	ABLE								
1-Pipe Insulation		NO BUILDINGS W	IGS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
3-Caulking		NO BUILDINGS W	IGS WITH SIR	ITH SIR GREATER THAN 1.0	THAN 1.0						
1-Wall Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER 1	THAN 1.0		` .				
2-Insulate Windows		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER 1	THAN 1.0						
9-Heat Reclaim		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER 1	THAN 1.0						

## TABLE ES-5 ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

				(CONC	(CONCLUDED)						
ECO	ANNUAL	ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNUAL	NON- ENERGY	TOTAL	CONST	SIR	SIMPLE PAYBACK
Ö.	SAVINGS (kW)	SAVINGS (kWh)	SAVINGS (MBtu)	SAVINGS (MBtu)	SAVINGS (\$)	CREDIT (\$)	SAVINGS (\$)	AVOID (\$)	(\$)		(yrs)
6-Economizer		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER TI	HAN 1.0						
17-Boiler		NOT APPLICABLE	ABLE								
16-Demand		NOT APPLICABLE	ABLE								
10-Air Stratification		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
13-Thermal Storage		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						

## **ENERGY PROJECT DEVELOPMENT**

The individual ECOs were grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided EMC with a list of buildings which have reimbursed utilities (NAF buildings) at Ft. Gillem. These facilities were eliminated from the possible ECIP funded projects. The Interim Submittal recommended ECIP projects were revised to take into account lower individual ECO construction cost estimates due to the elimination of these facilities.

At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1 Includes the following ECOs:
  - ECO 1, Add duct insulation
  - ECO 1, Add roof insulation
  - ECO 5, Install high efficiency electric motors
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 14, Provide infrared heaters
  - ECO 15, Separate (automatic) light switches
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits
- MCA Project 2 ECO 19, Previous lighting study review, for light fixture replacement

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low cost, no cost ECO to be done with in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR greater than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Table ES-6 on page ES-12 provides an economic summary of ECO projects which should be considered for funding. Overall, there are \$3,124,931 of potential Non-ECIP ECO projects, and \$115,416 of potential NAF projects to fund.

## TABLE ES-6 ECONOMIC PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
MCA Project 1	98	974,092	6,671	9,994	26,008	8,843	(433)	64,418	735,360	1.1	11.4
MCA Project 2	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
Low-Cost/ No-Cost ECO	0	0	66	66	460	0	550	1,010	925	13.5	6.0
NAF ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
NAF ECO-18	6	78,840	0	569	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	1,356	4,124,805	10,599	24,666	179,358	140,145	(682)	294,048	3,526,544		

## **RECOMMENDATIONS**

- It is recommended the Army fund the construction of the two MCA projects to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.
- It is recommended Fort Gillem DEH complete the low-flow shower and faucet fixture project (ECO-8) in-house, using operation and maintenance money and local government staff.
- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

## **ENERGY CONSUMPTION**

Electricity, natural gas, and water and sewer use will be conserved if the ECOs identified in this study are implemented.

Electrical energy consumption for FY90 and FY91 is tabulated in Table ES-7 on page ES-14. The average monthly electrical consumption varies from a minimum of 1,896,000 kWh in February, to a maximum of 3,048,000 kWh in August.

Natural gas consumption for FY90 and FY91 is tabulated in Table ES-8 on page ES-15. The average monthly natural gas consumption varies from a minimum of 12,437 therms in July, to a maximum of 300,308 therms in March.

## TABLE ES-7 ELECTRICAL ENERGY CONSUMPTION FORT GILLEM

Month	Post-wide Electrical Consumpt. kWh, FY90	Post-wide Electrical Consumpt. kWh, FY91	Post-wide Electrical Consumpt. kWh Avg.90/91
Oct.	2,035,200	2,304,000	2,169,600
Nov.	1,737,600	2,054,400	1,896,000
Dec.	2,131,200	2,102,400	2,116,800
Jan.	2,409,600	2,150,400	2,280,000
Feb.	1,920,000	2,227,200	2,073,600
March	2,121,600	1,958,400	2,040,000
April	1,920,000	2,112,000	2,016,000
May	2,236,800	2,140,800	2,188,800
June	2,707,200	2,649,600	2,678,400
July	2,755,200	2,793,600	2,774,400
Aug.	3,081,600	3,014,400	3,048,000
Sept.	2,515,200	2,544,000	2,529,600
TOTAL	27,571,200	28,051,200	27,811,200

## TABLE ES-8 NATURAL GAS CONSUMPTION FORT GILLEM

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	57,815	54,080	55,948
Nov.	155,197	124,669	139,933
Dec.	365,521	235,094	300,308
Jan.	209,241	299,628	254,435
Feb.	139,875	206,257	173,066
March	113,897	135,811	124,854
April	72,354	36,386	54,370
May	14,396	17,102	15,749
June	12,782	13,485	13,134
July	12,381	12,493	12,437
Aug.	13,431	13,182	13,307
Sept.	13,013	15,507	14,260
TOTAL	1,179,903	1,163,694	1,171,798

The percentage comparison of historical consumption and cost for electricity and natural gas are tabulated in Table ES-9 below. Table ES-10 below provides a comparison of the percent of energy and dollars saved after the ECOs recommended are implemented.

TABLE ES-9
FY91 UTILITY USAGE AND COST COMPARISON

UTILITY	CONSUMPTI	ON FY91	COST F	Y91
	(MBtu)	(%)	(\$)	(%)
Electricity	95,739	45	1,470,583	70
Natural Gas	116,369	55	644,169	30
Total	212,108	100	2,114,752	100

TABLE ES-10
PERCENT ENERGY AND DOLLAR SAVINGS

UTILITY	ENE	ERGY SAVIN	igs	DO	LLAR SAVIN	iGS
	Base Energy (MBtu)	Energy Savings (MBtu)	Percent Savings (%)	Base Energy (\$)	Energy Savings (\$)	Percent Savings (%)
Electricity	95,739	18,740	19.6	1,470,583	140,015	9.5
Natural Gas	116,369	21,972	18.9	644,169	102,609	15.9
Total	212,108	40,712	19.2	2,114,752	242,624	11.5

## **SECTION 1.0**

## INTRODUCTION

## 1.1 AUTHORITY FOR STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the U.S. Army Corps of Engineers, Savannah District, in September 1991.

## 1.2 PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

## 1.3 SCOPE OF WORK

The scope of work (SOW) for this study is defined in the contract entitled "Energy Savings Opportunity Survey" (ESOS), dated 18 June 1991, and includes the following major tasks:

- Conduct a limited site survey to evaluate the ECOs in the selected buildings.
- Obtain the necessary data to evaluate.
- Identify which ECOs are technically feasible, including low cost or no cost ECOs.
- Calculate the energy and dollar savings, and prepare cost estimates for each ECO determined to be technically feasible.
- Calculate the simple payback and savings-to-investment ratio (SIR) for each ECO.
- Prepare an Interim Submittal which illustrates the methods, justifications, and calculations of the approaches taken.
- Present, at a review conference, the work accomplished to date showing energy and dollar savings, simple payback, and SIR of all technically feasible ECOs.
- Combine technically and economically feasible ECOs into packages (in coordination with installation personnel) which will qualify for Energy Conservation Investment Program (ECIP) or Military Construction Program (MCP) funding.

The complete SOW for this study and related Confirmation Notices are included in Appendix A of this Volume I. For convenience, Table 1-1, starting on page 1-4, presents a detailed list of items required by the SOW and indicates where those items are presented in this report.

## 1.4 ORGANIZATION OF SUBMITTAL

Volume I of this submittal includes the following:

- Sections 1.1 and 1.2 contain introductory information relevant to the study and the
  preparation of the report, based on the SOW outlined in Section 1.3. This Section 1.4
  explains the organization of the report, while Section 1.5 describes the status of the
  study and the work remaining to complete the project. Section 1.6 describes previous
  energy studies at Fort Gillem.
- Section 2.0 describes the Fort Gillem utility rates and energy use for FY90 and FY91.
- Section 3.0 describes the ECOs evaluated, the analysis methodology, and the results of the ECO evaluations.
- Section 4.0 describes recommended energy conservation projects for future funding.
- Section 5.0 presents a summary of findings and recommendations.
- Appendices A through D provide backup calculations and contract documentation.

Volume II of this submittal includes the following:

- Appendix E includes computer simulations.
- Appendix F includes field survey notes.

## 1.5 WORK ACCOMPLISHED

With the completion of this Final Submittal the following items have been accomplished:

- Site survey.
- Entrance and exit interviews.
- Determination of base energy usage.
- Evaluation of ECOs.
- Calculation of ECO cost, annual energy savings, annual dollar savings, SIR, and simple payback period.
- Prioritization of ECOs by SIR.
- Preparation and delivery of Interim Submittal.

- Interim Submittal review conference.
- Update ECO projects, based on review comments.
- Combine technically and economically feasible ECOs into packages (in coordination with installation personnel) which will qualify for ECIP or MCP funding.
- Determine cost, annual energy savings, annual dollar savings, SIR, and simple payback period of the ECO packages.
- Prepare and deliver Prefinal Submittal.
- Prefinal Submittal review conference.
- Make revisions and corrections.
- Conduct an O&M briefing of the study results.
- Prepare and deliver Final Submittal.

## TABLE 1-1 SCOPE OF WORK SUMMARY ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
1	1 5	1.1 7.2	Perform limited site survey.	<del></del>
2	1	1.2	Evaluate ECOs to determine economic feasibility.	Volume I 3.0
3	1 6	1.3 7.3	Group recommended ECOs into projects for implementation.	Volume I 4.0
4	1	1.4	Prepare submittal.	
5	1	2.3	As a minimum, evaluate ECOs listed in Annex A.	Volume I 3.2
6	2 5	2.3 7.2	Determine if ECOs are technically feasible. Document ECOs considered not feasible.	Volume I 3.2
7	2 5	2.6 7.1	Use current ECIP criteria in performing analysis.	Volume I 3.4
8	2	2.7	Combine ECOs into larger packages for ECIP or MCP funding.	Volume I 4.0
9	2	2.7.1	List and prioritize, by SIR, projects which qualify for ECIP funding.	Volume I Table 3-32
10	2	2.7.2	Prioritize, by SIR, feasible non-ECIP projects.	Volume I 4.3
11	4 5	5.1 7.1	Develop life cycle cost analysis summary sheets for ECIP projects.	Volume I Appendix C
12	4	5.1	Provide original backup calculations from previous studies.	Volume I Appendix C
13	4	5.2	Develop life cycle cost analysis summary sheets for non-ECIP projects.	Volume I Appendix D
14	4	5.3	Document nonfeasible ECOs in the report.	Volume I 3.2
15	5	7.1	Analyze the ECOs listed in Annex A.	Volume I 3.4

## TABLE 1-1 SCOPE OF WORK SUMMARY (Continued) ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
16	6	7.1.2	Prepare calculation, showing all numbers and assumptions.	Volume I Appendix C
17	5	7.1	Utilize computer simulations on specified ECOs.	Volume I Appendix C
18	5	7.2	Document site survey, and provide completed forms as part of the report.	Volume II Appendix F
19	5	7.2	Thoroughly evaluate and document all potential ECOs which are not eliminated.	Volume I Appendix C
20	6 Conf. Notice 2	7.4 No. 8	Prepare a comprehensive report.	Prefinal Submittal
21	6	7.4	Give a formal presentation of the results.	<del></del> .
22	6	7.4.1	Interim Submittal - include analyses performed to date and results of field survey.	Interim Submittal
23	6	7.4.1	Interim Submittal - include copies of the Scope of Work and any modifications.	Volume I Appendix A
24	6	7.4.1	Interim Submittal - provide a narrative summary.	Executive Summary
25	. 6	7.4.1	Interim Submittal - include copies of field survey forms.	Volume II Appendix F
26	7 Conf. Notice 2	7.4.2 No. 5	Prefinal Submittal - document the integrated aspects of the study.	Volume I 4.0
.27	7	7.4.2	Prefinal Submittal - include an order of priority, by SIR, for the recommended ECOs.	Volume I 4.0

## TABLE 1-1 SCOPE OF WORK SUMMARY (Concluded) ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
28	7	7.4.2	Prefinal Submittal - include an executive summary per Annex D.	Executive Summary
29	7	7.4.2	Prefinal Submittal - list all projects and ECOs developed in the study.	Volume I 4.0
30	7	7.4.3	Final Submittal - incorporate revisions and corrections resulting from comments.	Final Submittal
31	5	7.2	Use metering equipment with the proper accuracies and calibration.	Volume II Appendix F
32	E-1		Present an operational and maintenance briefing.	<u></u>
33			Computer simulation printouts will be provided.	Volume II Appendix E

## 1.6 PREVIOUS UTILITY CONSERVATION STUDIES

During the course of this ESOS study, EMC reviewed a number of utility conservation studies completed by other firms for Fort Gillem. These studies include:

- "Feasibility Study For Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem," prepared by Stone & Webster Engineering Corporation, July 1990.
- "Basewide Energy Systems Plan For Ft. Gillem," prepared by JRB Associates, July 1980.

The results of the shared energy savings lighting retrofit project were reevaluated and incorporated in this study (see Section 3.4.19). Where practical, some technical information presented in these reports was utilized in the preparation of this report.

## **SECTION 2.0**

## UTILITY CONSUMPTION AND RATES

### 2.1 GENERAL

Fort Gillem is located within the city limits of Forest Park in Clayton County, Georgia, approximately 10 miles south of the central business district of Atlanta. It is also in close proximity to other, smaller cities such as College Park, Morrow, and Lake City, Georgia, all located south of Atlanta. The post occupies 1,500 acres of land, and extends approximately 2.5 miles in length and 1.5 miles in width, from U.S. Highway 23 and State Highway 42 (Moreland Avenue) on the east and State Highway 54 (Jonesboro Road) on the west. As a submission of Fort McPherson, Fort Gillem supports the officially stated mission of Fort McPherson, plus provides support to the mission of major Government activities facilitated at Fort Gillem, including the Army Air Force Exchange Service (AAFES) Eastern Distribution Center.

Electricity, natural gas, and water and sewer use can be conserved by ECOs evaluated in this study. The rates and historical consumption of these utility sources are discussed in this Section.

Utility consumption and rate backup calculations are provided in Appendix B of this Volume.

## 2.2 UTILITY RATES

## 2.2.1 Electrical Rates

Electrical energy is supplied to Fort Gillem under Schedule G-10, <u>Full Use Service to Government Institutions</u>, from Georgia Power Company. The current rates and contracted amounts have been in effect since 4 December 1991. The electrical rate is broken down into five parts, as follows:

- Base charge
- Consumption (energy) charge
- Power factor charge
- Fuel cost recovery charge
- Minimum monthly billing.

Base Charge: The base charge is \$55 per month.

## Consumption charge:

kWh less than 300 x billing demand	
Cost of first 50,000 kWh	\$0.0600 per kWh
Cost of next 150,000 kWh	\$0.0582 per kWh
Cost of next 800,000 kWh	\$0.0442 per kWh
Cost of over 1,000,000 kWh	\$0.0410 per kWh
kWh more than 300 x billing demand	\$0.0115 per kWh.

## Billing demand is greatest of:

- (1) Current monthly actual demand
- (2) 95% of highest demand in previous June through September
- (3) 60% of highest demand in previous October through May.

## Power factor charge:

Power factor < 95% \$0.27 per kVAR.

Currently, the power factor is above 95% and there has been no charge.

## Fuel cost recovery charge:

Monthly adjustment x total kWh.

The fuel cost recovery rate is \$0.0140/kWh.

## Minimum monthly bill:

\$55 base charge

- + \$8 per kW of billing demand (but not less than \$3,400)
- + power factor charge and fuel cost recovery.

## 2.2.2 Natural Gas Rates

Natural gas is supplied to Fort Gillem under rate N-16, <u>Large Commercial Interruptible Service</u>, from Atlanta Gas Light. The current rates and contracted amounts have been in effect since 1992. The natural gas rate is broken down into four parts, as follows:

- Monthly customer charge
- Firm use charge
- Consumption (energy ) charge
- Gas adjustment charge.

Monthly customer charge: \$250.

Firm use charge: \$10,400 (Based on minimum daily availability of 8,000 therms at \$1.30.)

## Consumption charge:

Monthly meter reading

(MCF)  $\times$  10.29 therms/MCF = therms

Cost of first 100,000 therms	\$0.070 per therm
Cost of next 200,000 therms	\$0.057 per therm
Cost of over 300,000 therms	\$0.047 per therm.

## Gas adjustment charge:

Monthly adjustment x total therms.

The average gas adjustment charge for calendar years 1990 and 1991 was \$0.397/therm, which accounts for 67% of annual gas costs at Fort Gillem.

#### 2.2.3 Water and Sewer Rates

The charges for water services from the Atlanta Water System include the following:

## Water Charges

Cost of first 3 CCF (base charge)	\$3.35 total
Cost of next 67 CCF	\$1.70 per CCF
Cost of next 600 CCF	\$1.04 per CCF
Cost of over 670 CCF	\$0.72 per CCF.

The charges for sewage service from the City of Forest Park, separately metered from water, include the following:

# Sewage Charges

Cost of first 2 gallons (base charge)	\$6.00 total
Cost over 2 gallons	1.95 per thousand gallons

## 2.3 HISTORICAL CONSUMPTION OF UTILITIES

Historical utility usage data for Fort Gillem was evaluated so savings figures could be compared with actual consumption.

# 2.3.1 Historical Electrical Energy Consumption

Electrical energy consumption for FY90 and FY91 is tabulated in Table 2-1 on page 2-4. The average monthly electrical consumption varies from a minimum of 1,896,000 kWh in February, to a maximum of 3,048,000 kWh in August. The monthly electrical consumption is illustrated graphically on Figure 2-1 on page 2-5.

# TABLE 2-1 ELECTRICAL ENERGY CONSUMPTION FORT GILLEM

Month	Post-wide Electrical Consumpt. kWh, FY90	Electrical Electrical Consumpt. Consumpt.			
Oct.	2,035,200	2,304,000	2,169,600		
Nov.	1,737,600	2,054,400	1,896,000		
Dec.	2,131,200	2,102,400	2,116,800		
Jan.	2,409,600	2,150,400	2,280,000		
Feb.	1,920,000	2,227,200	2,073,600		
March	2,121,600	1,958,400	2,040,000		
April	1,920,000	2,112,000	2,016,000		
May	2,236,800	2,140,800	2,188,800		
June	2,707,200	2,649,600	2,678,400		
July	2,755,200	2,793,600	2,774,400		
Aug.	3,081,600	3,014,400	3,048,000		
Sept.	2,515,200	2,544,000	2,529,600		
TOTAL	27,571,200	28,051,200	27,811,200		

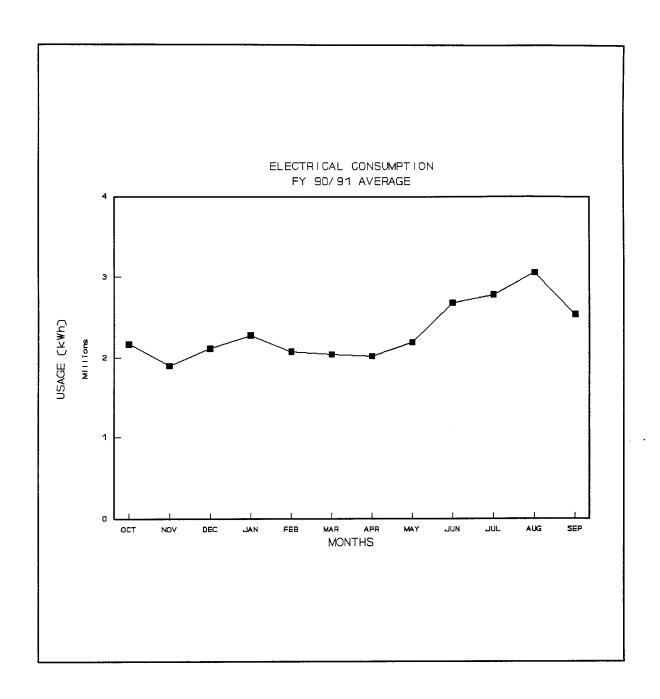


FIGURE 2-1 ELECTRICAL CONSUMPTION

# 2.3.2 Historical Natural Gas Consumption

Natural gas consumption for FY90 and FY91 is tabulated in Table 2-2 below. The average monthly natural gas consumption varies from a minimum of 12,437 therms in July, to a maximum of 300,308 therms in March. The monthly natural gas consumption is illustrated graphically in Figure 2-2 on page 2-7.

TABLE 2-2 NATURAL GAS CONSUMPTION FORT GILLEM

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	57,815	54,080	55,948
Nov.	155,197	124,669	139,933
Dec.	365,521	235,094	300,308
Jan.	209,241	299,628	254,435
Feb.	139,875	206,257	173,066
March	113,897	135,811	124,854
April	72,354	36,386	54,370
May	14,396	17,102	15,749
June	12,782	13,485	13,134
July	12,381	12,493	12,437
Aug.	13,431	13,182	13,307
Sept.	13,013	15,507	14,260
TOTAL	1,179,903	1,163,694	1,171,798

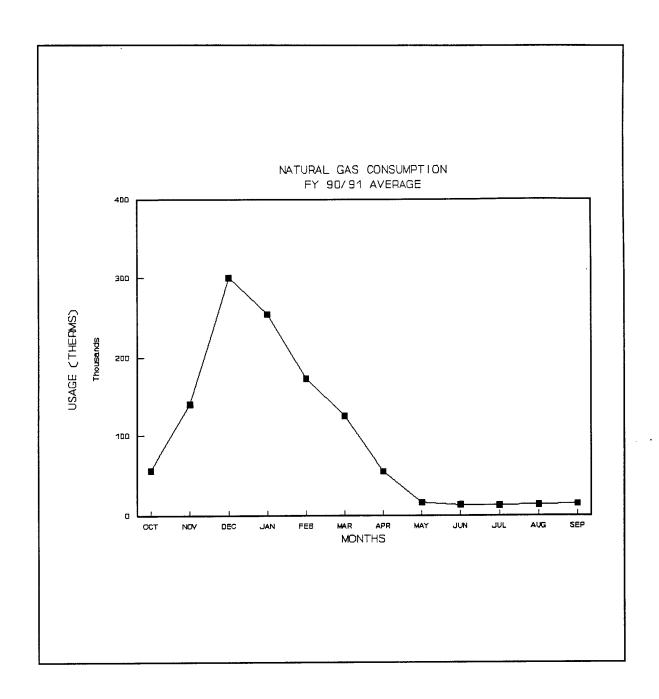


FIGURE 2-2 NATURAL GAS CONSUMPTION

### 2.4 SUMMARY OF UTILITIES

The percentage comparison of historical consumption and cost for electricity and natural gas are tabulated in Table 2-3 below.

TABLE 2-3
FY91 UTILITY USAGE AND COST COMPARISON

UTILITY	CONSUMPTI	ON FY91	COST FY91			
	(MBtu) (%)		(\$)	(%)		
Electricity	95,739	45	1,470,583	70		
Natural Gas	116,369	55	644,169	30		
Total	212,108	100	2,114,752	100		

## 2.5 BASIS FOR ECONOMIC ANALYSIS

## 2.5.1 ECIP Guidance

The ECIP funding program criteria were used to determine project economics. The latest version of "Life Cycle Cost in Design (LCCID)" program, developed by the U.S. Army Construction Engineering Research Laboratory, was used to calculate life cycle cost benefits. The maximum economic life and uniform present worth (UPW) factors for natural gas, electricity, and non-energy items for DOE Region 3, from NISTIR-85 are listed in Table 2-4 on page 2-9.

TABLE 2-4
UNIFORM PRESENT WORTH FACTORS

CATEGORY	MAXIMUM ECONOMIC LIFE	UPW ELEC- TRICITY	UPW NATURAL GAS	UPW NON- ENERGY
Steam and condensate systems (including insulation)	25	15.61	23.77	14.53
HVAC, including controls	15	11.11	14.45	10.59
Weatherization	25	15.61	23.77	14.53
Lighting status	25	15.61	23.77	14.53
Energy recovery systems	25	15.61	23.77	14.53
Electrical energy systems, including motor replacements	25	15.61	23.77	14.53

# 2.5.2 Basis for Energy Cost Savings Benefits

Unit utility costs were calculated from contract information and historical data, to be used with the energy savings in order to estimate the dollar cost avoidance.

For electricity, the following unit cost was used:

Average electrical energy charge = \$0.0255 per kWh
 Annual peak electrical demand charge = \$8.85 per kW.

For natural gas, the following unit cost was used:

• Average natural gas energy charge = \$4.67 per MBtu.

For water and sewer, the following unit cost was used:

• Combined water and sewer charge = \$2.91 per thousand gallons.

#### 2.5.3 Basis for Labor and Material Costs

The following sources were used to develop the cost estimates of materials:

- Mean's Cost Data, 1992 Editions
- Actual cost from similar construction projects
- Equipment vendor estimates.

#### 2.6 DEMAND SIDE MANAGEMENT

On January 10, 1992, Georgia Power Company submitted for approval to the state Public Service Commission of Georgia 14 energy efficiency, demand side management programs. The Public Service Commission of Georgia has 300 days to accept or reject the programs or to provide an alternative programs.

The proposed programs will potentially provide Fort Gillem future incentives for demand side management conversions. Of interest to Fort Gillem are those programs in the categories of Commercial and Industrial Areas, Process Systems, and Buildings Systems.

## Process systems include:

- Motors
- Custom energy services
- Small energy services
- Energy analysis
- Interruptible service.

# Building systems include:

- Lighting
- HVAC
- New construction
- Standby generation.

If the demand side management program is approved by the Public Service Commission of Georgia, various ECOs evaluated in this ESOS could receive incentives. A preliminary statement issued by the Commission on 7 July 1992 did not include a decision on the demand side management program.

#### **SECTION 3.0**

# **EVALUATION OF ENERGY CONSERVATION OPPORTUNITIES**

#### 3.1 GENERAL

A total of 17 ECO projects were evaluated in this study. The evaluation of each ECO was performed as if it were the only ECO implemented. Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. A summary of the ECOs evaluated is provided in Section 3.5.

#### 3.2 ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table 3-1 on page 3-2.

During the entrance interview conference, ECO 18 was added, which uses a replacement kit to convert exit signs from incandescent lamps to fluorescent lamps. ECO 18 was evaluated for all buildings specified for ECO 15, lighting controls.

After discussions with DEH, it was also agreed to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

After the survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which were not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated are included in Table 3-2 beginning on page 3-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list. Table 3-3 on page 3-3 lists buildings added to the ECO evaluations.

Table 3-4 beginning on page 3-4 is a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

# TABLE 3-1 ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE 3-2 NONFEASIBLE ECOs

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
207	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
400	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
401	5	No motors 1 horsepower or larger
401	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
403	5	No motors 1 horsepower or larger
701-710, 198, 922, 923, 942	All ECOs	Buildings scheduled for demolition

TABLE 3-3 BUILDINGS ADDED

ECO NO.	BLDG NO.	COMMENTS
8	935	Evaluate low-flow showers and faucets
13	101	Evaluate thermal storage
18	101, 103, 207, 213, 400, 401, 512, 935	Evaluate exit sign retrofits
	935	Evaluate exit sign retrofits

TABLE 3-4
BUILDING-ECO MATRIX

	_	1	T	T	Ť	T	i –	<del>                                     </del>	T		T		_			7		
	19	*V	*\	*4	*<	*V	*V	, *A	*V	<b>A</b> *	<b>A</b> *	<b>A</b> *	<b>A</b> *	*A	<b>A</b> *	<b>A</b> *	* Y	A*
	18	<b>A</b> *		A*		A*	A*			A*	<b>A</b> *							
	17											V	4	<	⋖	4	⋖	٧
	16	A	A	A	∢	V	V	V	V	⋖	A	4	A	V	⋖	V	V	A
	15	A		∢		⋖	V			A	A							
	14					A		A		A	z					·		
	13	A*																
	12	A																
BER	11																	
ECO NUMBER	10		A			A		A		A	A							
ECO	6	Α			Α													
	8																	
	7	Α																
	9	А																
	5	А	A	A	Α	Α	А	Α	Α	А	Z	Z	Α					
	4	A	Α	Α	A	Α	Α	А	A	Α	А	Α	Α					
	3	V				<b>A</b> *												
	2	А				A*												
	1	A				<b>A</b> *												
DESCRIPTION		Administration	Maintenance	Fire Station	Officers Club	Storage	CID Building	Commissary	Storage	DOL	Eighty-first Arc.	Dining Facility	Storage	Storage	Storage	Storage	Storage	Storage
BLDG #	#	101	102	103	133	202	213	214	308	400	401	403	505	206	202	208	206	510

A - Applicable and evaluated project
 N - Not applicable and dropped from further analysis
 A\* - Added as an applicable project

TABLE 3-4
BUILDING-ECO MATRIX

	_					Γ.	T _
	19	*V	*V	*V	*V	*V	*V
	18		*A				*Y
	17	A		V	∢		
	16	٧	A	V	A	A	V
	15		Α				Y
	14		A				
	13						
	12						
IBER	11						
ECO NUMBER	10		Α				
ECO	6						
	8						<b>A</b> *
	7						
	9						
	5		Α			Α	A
	4		А			Α	A
	3		٧			A	
	2		٧			Α	
	1		V			Α	
DESCRIPTION		511 Storage	512 Storage {1}	Storage	514 Storage	735 Theater (T)	Fitness Center
BLDG	#	511	512	513	514	735	935

{1} Representative of Buildings 505 through 514

<sup>A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A\* - Added as an applicable project</sup> 

#### 3.3 ANALYSIS METHODOLOGY

The methodology used for the energy savings and economic analyses includes:

- Prepare computer simulation of selected buildings.
- Run a modified computer simulation of selected buildings, with the ECO implemented, to determine the delta energy usage.
- Develop energy savings factors to extrapolate savings for typical buildings to similar buildings.
- Apply extrapolated energy savings factors to similar buildings.
- Estimate utility savings for various ECOs using manual calculations.
- Prepare cost estimate for ECOs.
- Calculate the total savings and costs for each ECO, including non-energy savings or costs.
- Perform an LCCID calculation to determine the project simple payback and SIR.
- Recommend ECO projects which have an overall project SIR greater than 1.0
- See Appendix C of this Volume I for backup data on all ECOs.
- See Appendix E of Volume II for computer simulations of selected buildings.
- See Appendix F of Volume II for field survey data describing current conditions.

Special items considered in the analysis included:

- Using Atlanta weather data, the TRACE building simulation program was used to develop utility consumption estimates for three selected buildings. Table 3-5 on page 3-7 is a list of the selected buildings simulated and similar buildings for which estimates were extrapolated.
- Where applicable, the following ECOs were simulated on the selected buildings;
   the energy savings were then extrapolated to similar buildings:
  - ECO 1, Insulation (Wall and Roof)
  - ECO 2, Insulated Windows
  - ECO 3, Weatherstripping and Caulking
  - ECO 6, Economizers
  - ECO 7, Control Hot Water Circulation Pumps
  - ECO 10, Prevent Air Stratification

- ECO 12, Revise or Repair HVAC Controls
- ECO 13, Thermal Storage
- ECO 15, Separate Light Switches
- ECO 17, Boiler Operation Schedule
- The utility savings for the following ECOs were determined using manual calculations:
  - ECO 1, Insulation (Pipe and Duct)
  - ECO 4, Domestic Hot Water Temperatures
  - ECO 5, High Efficiency Electric Motors
  - ECO 8, Low-Flow Shower and Faucet Fixtures
  - ECO 9, Heat Reclaim from Hot Refrigerant Gas
  - ECO 11, Replace Street Lights
  - ECO 14, Radiant Heaters and Loading Dock Seals
  - ECO 16, Investigate Post Demand Usage
- See Section 2.0 for utility rates and economic analysis descriptions.

#### 3.4 ECO ANALYSIS

The following ECO sections detail the premises, field survey requirements, basis for analysis, energy savings calculations, improvement descriptions, results, and recommendations for each of the 19 ECOs to be evaluated in this study. Section 4.0 provides an economic summary of the ECOs evaluated. The construction cost identified in the ECO evaluations includes design cost (6%) and SIOH (5.5%). These additional costs were included after the Interim Submittal.

TABLE 3-5
COMPUTER SIMULATION BUILDINGS

BLDG. NUMBER	BLDG. FUNCTION	BLDG. CONSTRUCTION	BLDG. OCCUPANCY	SIMILAR BLDG. NUMBERS
101	Administration	Brick & Block	0700-1700 Mon. to Fri.	
207	Storage	Block	0700-1600 Mon. to Fri.	207, 214, 400, 401, 512
M358	Administration	Frame	0700-1600 Mon. to Fri.	735

#### 3.4.1 ECO 1 - INSULATION

#### 3.4.1.1 - Insulate Walls and Roofs

#### Premise:

This ECO involves adding insulation to existing walls and roofs which are inadequately insulated.

## Field Survey:

The walls and roofs were surveyed to determine whether they contain adequate insulation. It was difficult to determine what insulation was present in the buildings with framed-in walls. Discussions with DEH revealed, however, recently remodeled buildings can be assumed to have R-11 fiberglass batt insulation in the walls and R-19 insulation in the ceiling space. This assumption was verified, when possible, by examination of construction plans.

## Basis for Analysis:

Heat transfer through the walls and roof of a building is related to the resistance of the construction materials to heat flow. By increasing the resistance of the materials, heat transfer is reduced and energy saved. The most effective way to reduce heat transfer is to add insulation, thereby lowering the U-value. As the U-value decreases, the energy consumption will also decrease, thereby increasing the energy savings. The existing building wall and roof insulation can be improved, as follows:

## Wall Insulation:

# Bldg. 101:

1" isocyanurate and gypsum board can be installed on the interior of the frame wall for an increased R-value of 9.

Bldgs. 207, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514:

2" polystyrene and stucco can be installed on the exterior of the brick wall for an added R-value of 10.

#### Roof Insulation:

Bldgs. 207, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514:

3-inch isocynurate can be attached to the interior of the existing roof for an added R-value of 21.6.

#### **Energy Savings Calculations:**

First, the buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was created to simulate the typical building, using a UA (U-value x Area) factor improved by additional insulation. These two models were compared as to the difference in UA factor and the corresponding difference in building energy consumption. The ratio of

# 3.4.1 ECO 1 - INSULATION (Continued)

# 3.4.1.1 Insulate Walls and Roofs (Continued)

energy savings per unit UA differential was calculated and applied to the rest of the buildings in the group to determine the annual energy savings for each building.

The following equations were used:

Existing UA = (existing U-value) x (surface area)

Improved UA = (improved U-value) x (surface area)

Differential UA = existing UA - improved UA

Electric savings = (UA differential) x (electric savings factor)

Demand savings = (UA differential) x (demand savings factor)

Gas savings = (UA differential) x (gas savings factor)

where:

Existing U-value = Existing U-value of wall materials

Improved U-value = Improved U-value (with insulation added)
Surface area = Net wall or roof surface area from plans

Electric savings/UA ratio = Calculated electric savings per change in UA for

typical building

Demand savings factor = Calculated demand savings per change in UA

for typical building

Gas savings/UA ratio = Calculated gas savings per change in UA for

typical building

Tables 3-6 and 3-7 on pages 3-11 and 3-12 contain the results of analysis of this ECO.

# 3.4.1 ECO 1 - INSULATION (Continued)

## 3.4.1.1 Insulate Walls and Roofs (Continued)

Results: Walls

There were no buildings with an SIR greater than 1.0.

**Recommendation:** Do not implement.

Results: Roofs (Combined results for buildings with an SIR greater than 1.0.)

1.2

Annual Natural Gas Savings (MBtu) 34,889 891,090 Annual Electrical Energy Savings (kWh) Annual Demand Savings (kW) 0 \$0 Annual Non-Energy Cost Savings \$185,656 **Total Annual Cost Savings Estimated Construction Cost** \$3,538,381 Analysis Period (years) 25 Simple Payback (years) 19

Recommendation: Implement.

Savings-to-Investment Ratio (SIR)

TABLE 3-6 ECO 1, WALL INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	19	18,111	217	279	1,477	1,921	0	3,398	135,814	0.4	40
207	0	2,920	92	98	430	0	0	430	135,899	0.1	316
505	0	2,249	28	99	330	0	0	330	105,101	0.1	319
206	0	2,249	28	99	330	0	0	330	105,101	0.1	319
202	0	2,249	28	99	330	0	0	330	102,101	0.1	319
508	0	2,249	28	99	330	0	0	330	105,101	0.1	319
509	0	2,249	28	99	330	0	0	330	105,101	0.1	319
510	0	2,249	58	99	330	0	0	330	105,101	0.1	319
511	0	2,249	58	99	330	0	0	330	105,101	0.1	319
512	0	2,249	58	99	330	0	0	330	105,101	0.1	319
513	0	2,249	58	99	330	0	0	330	102,101	0.1	319
514	0	2,249	58	99	330	0	0	330	105,101	0.1	319

TABLE 3-7 ECO 1, ROOF INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
505	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
206	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
202	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
508	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
509	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
510	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
511	00	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
512	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
513	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
514	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
207	0	78,255	4,109	4,479	21,957	0	0	21,957	419,503	1.2	19
Total	0	891,090	34,889	37,928	185,656	0	0	185,656	3,538,381	1.2	19

#### 3.4.1 ECO 1 - INSULATION

# 3.4.1.2 - Insulate Pipes and Ducts

#### Premise:

This ECO involves reducing energy consumption by adequately insulating ducts and pipes.

## Field Survey:

Ducts and pipes in the unconditioned spaces (e.g., attics, crawl spaces, and mechanical rooms) of various buildings were surveyed. Ducts and pipes in conditioned spaces were not surveyed because heat transfer between the fluid and the space contributes to the conditioning of a space and is not considered a loss. The lengths and sizes of the ducts and pipes were determined from building drawings and field measurements. Type of fluid, type of insulation, and thickness of insulation were considered. In most cases, pipes and ducts were insulated.

## **Basis for Analysis:**

Uninsulated or poorly insulated ducts and pipes in unconditioned spaces waste energy; adding adequate insulation will reduce losses. For the purpose of this analysis, adequate insulation thickness is defined as the recommended thickness from Corps of Engineers guide specifications and ASHRAE Standard 90.1 - 1989. Table 3-8 on page 3-16 lists the recommended thicknesses for pipes and ducts used in this ECO. These recommended thicknesses were compared with the survey data of existing insulation. Where it was determined pipes and ducts had no insulation or did not meet recommended insulation thickness, an analysis was done to determine the savings and costs involved with adding enough insulation to achieve the recommended thickness.

## **Energy Savings Calculations:**

The energy savings for this ECO were calculated by subtracting the heat loss of ducts and pipes with recommended insulation thickness from the heat loss of pipes and ducts with existing insulation. The energy savings from a reduction in air leakage for ducts with no insulation was also taken into account. The following equations were used:

#### <u>Pipes</u>

Heat loss, Btu/h

$$= \frac{L(tf - ta)}{Rt}$$

Rt, Total thermal resistance,  $\frac{\circ F}{Btu}$ 

Rc, Convection resistance,  $\frac{\circ F}{Btu}$ 

$$= \frac{1}{(.18(ts - ta)^{.33}(Pi(d+2w))}$$

# 3.4.1.2 Insulate Pipes and Ducts (Continued) Energy Savings Calculations: (Continued)

= ln(ro/ri)

 $= ta + \underline{Rc} (tf - ta)$ Rc + Rd

2kPi

where:

tf

= Fluid temperature, °F

ta

= Ambient temperature, °F

w, inches

= Insulation thickness

k, Btu hr ft °F

= Thermal conductivity of insulation

L, feet

= Pipe length

d, inches

= Pipe diameter

Pi

= 3.14

ro, inches

= outside radius of pipe and insulation

ri, inches

= inside radius of insulation

**Ducts** 

Heat loss (insulation), Btuh

= UA(tf - ta)

U, <u>Btu</u> h °F ft2

= 0.65Rd, average conduction resistance, °F h

Rc, average convection resistance, °F h

RI, thermal resistance of insulation, °F h  $=\frac{1}{(k/w)}$ 

Btu

Heat loss (leakage-winter), Btuh

= 1.1 cfm (tf - ta)

Heat loss (leakage-summer), Btuh

= 4.5 cfm (delta enthalpy)

cfm

 $= \underline{FA}$ 100

F, leakage ratio cfm/100 ft<sup>2</sup>

 $= C_L P^{0.65}$ 

## 3.4.1.2 Insulate Pipes and Ducts (Continued)

where:

tf, °F = Fluid temperature

ta, °F = Ambient temperature

A, square feet = Duct surface area

k, <u>Btu</u> = thermal conductivity of insulation

w, inches = Insulation thickness

 $C_L$ , cfm/100 ft<sup>2</sup> @ 1 inch wg = leakage class

P, inches wg = static pressure

Tables 3-9 and 3-10 on page 3-17 provide economic summaries for this ECO.

Results: Pipes

There were no buildings with an SIR greater than 1.0.

**Recommendation:** Do not implement.

Results: Ducts

38 Annual Natural Gas Savings (MBtu) 4,596 Annual Electrical Energy Savings (kWh) Annual Demand Savings (kW) 0 Annual Non-Energy Cost Savings \$0 Total Annual Cost Savings \$295 **Estimated Construction Cost** \$2,040 Analysis Period (years) 25 Simple Payback (years) 6.9 Savings-to-Investment Ratio (SIR) 3.0

Recommendation: Implement.

TABLE 3-8 ECO 1.2, DUCT AND PIPE RECOMMENDED THICKNESSES

FLUID		PIP	E SIZE (in	ches)	
	0.25 - 1.00	1.25 - 2.00	2.25 - 3.00	3.25 - 4.00	4.25 - 6.0
CHILLED WATER PIPES					
Fiberglass	0.50	0. <i>7</i> 5	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES	:				
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS			All Sizes		
		2	2" Fiberglas	SS	

TABLE 3-9 ECO 1, PIPE INSULATION

Diag.	Peak	Annual	Annual	Total	Annual	Annual	Annual	Total	Const.	SIR	Simple
	Demand	Electric	Gas	Energy	Energy	Demand	Non-	Annual	Cost		Payback
Š.	avings	Savings	Savings	Savings	Savings	Savings	Energy	Savings	<del>(\$</del> )		(yrs)
	(kW)	(kWh/yr)	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	Savings	(\$/yr)			
							(\$/yr)				
101	0	0	7	4	34	0	0	34	1,997	0.4	58.6

TABLE 3-10 ECO 1, DUCT INSULATION

	_	_	
Simple Payback (yrs)	4.2	20.8	6'9
SIR	5.0	1.0	3.0
Const. Cost (\$)	1,020	1,020	2,040
Total Annual Savings (\$/yr)	246	49	295
Annual Non- Energy Savings (\$/yr)	0	0	0
Annual Demand Savings (\$/yr)	0	0	0
Annual Energy Savings (\$/yr)	246	49	295
Total Energy Savings (MBtu/yr)	45	6	54
Annual Gas Savings (MBtu/yr)	32	9	38
Annual Electric Savings (kWh/yr)	3,770	978	4,596
Peak Demand Savings (kW)	0	0	0
Bldg.	735	101	Total

#### 3.4.2 ECO 2 - INSULATED WINDOWS

#### Premise:

This ECO involves replacing existing single pane windows with insulated glass (double pane) windows.

## Field Survey:

Selected buildings were surveyed to examine the windows and determine whether they were single or double pane windows. Buildings which already have double pane windows were eliminated from the analysis. Many of the historical buildings have single pane windows.

## Basis for Analysis:

Heat transfer through a window is a function of its resistance to heat flow (U-value) and solar radiation gains (shading coefficient). Replacing single panes with double panes lowers both the U-value and shading coefficient of a window, resulting in decreased heat flow and solar radiation gains. Energy savings are thus achieved. In historical buildings, replacement windows would have the same appearance as the existing windows.

## **Energy Savings Calculations:**

The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate double pane windows. The difference in energy consumption between the two models is the energy savings. The energy savings per square foot of window area was calculated and extrapolated to the rest of the buildings in the group, to calculate the annual energy savings for each building. The following equations were used:

Electric savings = (window area) x (electric savings per sqft)

Demand savings = (window area) x (demand savings per sqft)

Gas savings = (window area) x (gas savings per sqft)

Table 3-11 on page 3-19 provides an economic summary of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

**Recommendation:** Do not implement.

TABLE 3-11 ECO 2, INSULATED WINDOWS

Simple Payback (yrs)	116	116	116	116	116	116	116	116	116	116	116	197	455
SIR	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Const. Cost (\$)	121,955	121,955	121,955	121,955	121,955	121,955	121,955	121,955	121,955	121,955	183,878	31,125	2,751
Total Annual Savings (\$/yr)	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,589	158	9
Annual Non- Energy Savings (\$/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Demand Savings (\$/yr)	0	0	0	0	0	0	0	0	0	0	930	0	0
Annual Energy Savings (\$/yr)	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	1,049	099	159	9
Total Energy Savings (MBtu/yr)	216	216	216	216	216	216	216	216	216	216	134	33	1
Annual Gas Savings (MBtu/yr)	201	201	201	201	201	201	201	201	201	201	123	30	1
Annual Electric Savings (MBtu/yr)	4,398	4,398	4,398	4,398	4,398	4,398	4,398	4,398	4,398	4,398	696'6	<u> </u>	(6)
Peak Demand Savings (kW)	0	0	0	0	0	0	0	0	0	0	0	0	0
Bldg.	505	909	202	208	209	510	511	512	513	514	101	207	735

#### 3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING

#### Premise:

This ECO involves providing weatherstripping and caulking around windows and doors to reduce infiltration.

## Field Survey:

Selected buildings were surveyed to examine the weatherstripping and caulking around doors and windows. The condition of the weatherstripping and caulking varied greatly in the buildings; overall, weatherstripping and caulking were in fair condition.

## **Basis for Analysis:**

Outside air infiltration into a building through cracks, openings, and gaps around doors and windows increases building heating and cooling loads. Adequate weatherstripping and caulking around the windows and doors decreases the amount of infiltration into the building, which saves energy.

## **Energy Savings Calculations:**

The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate reduced infiltration achieved by the addition of weatherstripping and caulking. The difference in energy consumption between the two models is the energy savings. The energy savings per cfm of infiltration was calculated and extrapolated to the rest of the buildings in the group to calculate the annual energy savings for each building. The following equations were used:

Infiltration Air Flow =  $L(A(dT) - B(v^2))^{1/2}$ 

Delta Infiltration = Existing infiltration air flow - improved infiltration air

flow

Annual Electric Savings = (Infiltration savings) x (electric savings per cfm of

infiltration)

Annual Demand Savings = (Infiltration savings) x (demand savings per cfm of

infiltration)

Annual Gas Savings = (Infiltration savings) x (gas savings per cfm of infiltration)

Where:

= effective leaking area = (leakage area) x (leakage factor)

Infiltration air flow, cfm = Calculated infiltration for doors and windows

# 3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING (Continued)

**Energy Savings Calculations:** (Continued)

A,  $cfm^2 in^4 f^{-1}$  = ASHRAE stack coefficient for building

dT, °F = Avg. temperature difference between inside and outside

B,  $cfm^2 in^4 f^2$  = ASHRAE wind coefficient for building

v, mph = Avg. local wind speed

Leakage area,  $ft^2$  = Area of doors and windows

Leakage factor, in<sup>2</sup>/ft<sup>2</sup> = ASHRAE coefficient to account for weatherstripping and

caulking

Electric savings per cfm

of infiltration savings = Calculated electric savings per change in infiltration for

typical building

Demand savings per cfm

of infiltration savings = Calculated demand savings per change in infiltration for

typical building

Gas savings per cfm

of infiltration savings = Calculated gas savings per change in infiltration for

typical building

Table 3-12 on page 3-22 provides an economic summary of this ECO.

**Results:** There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

TABLE 3-12 ECO 3, WEATHERSTRIPPING AND CAULKING

T											,,		
Simple Payback (yrs)	70	098	313	313	313	313	313	313	313	313	313	313	310
SIR	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Const. Cost (\$)	21,926	13,756	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	1,474
Total Annual Savings (\$/yr)	313	38	99	99	99	99	66	99	66	99	99	99	5
Annual Non- Energy Savings (\$/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Demand Savings (\$/yr)	208	0	0	0	0	0	0	0	0	0	0	0	3
Annual Energy Savings (\$/yr)	105	38	99	99	99	99	99	99	99	99	99	99	2
Total Energy Savings (MBtu/yr)	21	8	14	14	14	14	14	14	14	14	14	14	0
Annual Gas Savings (MBtu/yr)	19	7	13	13	13	13	13	13	13	13	13	13	0
Annual Electric Savings (kWh/yr)	699	178	302	307	302	307	307	307	307	307	307	307	10
Peak Demand Savings (kW)	2	0	0	0	0	0	0	0	0	0	0	0	0
Bldg.	101	207	202	206	202	508	209	510	511	512	513	514	735

#### 3.4.4 ECO 4 - DOMESTIC HOT WATER TEMPERATURE

## Premise:

The purpose of this ECO is to measure the temperature of the domestic hot water (DHW) in selected buildings.

# Field Survey:

A field survey was performed to measure the DHW temperatures at various faucet locations in the building. These temperatures ranged from a low of 92°F in Building 400 to a high of 156°F in Building 403. Table 3-13 beginning on page 3-24 lists the measured DHW temperatures. To minimize energy consumption, set the water heater thermostat at the lowest temperature at which hot water will meet the occupants' needs.

TABLE 3-13 ECO 4, DOMESTIC HOT WATER TEMPERATURE MEASUREMENTS

Bldg. No.	Bldg. Descript.	Hot Wtr Temp.	Bldg. No.	Bldg. Descript.	Hot Wtr Temp.	Bldg. No.	Bldg. Descript.	Hot Wtr Temp.
101	Admin.	150	214	Commissary	139	505	Storage	144
101	Admin.	141	214	Commissary	130	505	Storage	151
102	Maint.	128	214	Commissary	146	512	Storage	101
102	Maint.	138	308	Storage	140	512	Storage	129
103	Fire Stn	133	400	DOL	131	513	Storage	144
103	Fire Stn	134	400	DOL	96	513	Storage	151
133	Club	155	400	DOL	92	735	Theater	155
133	Club	152	400	DOL	110	735	Theater	155
202	Storage	142	401	81st	108	935	Fitness	129
207	Storage	142	403	Dining	120			
207	Storage	125	403	Dining	136			
213	CID Bldg	122	403	Dining	156			

### 3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

#### Premise:

This ECO involves replacing existing standard efficiency motors with new highefficiency motors to save electrical energy in selected buildings.

## Field Survey:

Nameplate data was collected on existing motors and the power consumption of motors above 10 hp was measured (see Appendix E). Motors having measured FLA 25% less or 10% more than the nameplate FLA were noted. This condition could indicate the motors are undersized or oversized, respectively, for the application. Most motors were NEMA Design B, with standard efficiency ratings.

## **Basis for Analysis:**

Motor efficiency is the ratio of the energy output of the motor to energy input. The lower the efficiency, the more energy will be expended for a given output. By replacing standard efficiency motors with premium efficiency motors, electrical energy will be saved.

# **Energy Savings Calculations:**

Energy savings was calculated by subtracting the electrical demand of a premium efficiency motor from that of the existing motor and multiplying that difference by the annual hours of operation. The following equations were used:

Electrical demand (kW) =  $(hp \times 0.746 \times LF) \times (1/motor \, eff.)$ 

Electrical energy savings (kWh/yr) = ((kW of existing motor) - (kW of high)

efficiency motor)) x (hrs of operation

per yr)

where:

hp = Motor nameplate horsepower

0.746 = kW per horsepower LF = Motor load factor Motor eff. = Efficiency of motor

Nameplate information was used for existing motors. If nameplate information was not available on existing motors, data for a NEMA Design B, 1750 rpm, standard motor was used. The savings available due to premium efficiency motors was corrected for motor load. For motors controlled by variable frequency drives, the motor load was reduced to account for annual load factor reduction due to variable volume HVAC equipment. The efficiency of the variable frequency drive would remain the same for either type of motor, and does not change the predicted savings.

# 3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS (Continued)

Table 3-14 on page 3-27 provides an economic summary of this ECO.

## **Results:**

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	71,225
Annual Demand Savings (kW)	11
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$2,918
Estimated Construction Cost	<b>\$37,</b> 154
Analysis Period (years)	25
Simple Payback (years)	12.7
Savings-to-Investment Ratio (SIR)	1.2

# **Recommendation:** Implement.

If electric motors are being replaced due to failure, the DEH should consider replacing standard efficiency motors with premium efficiency motors. The differential cost of a premium efficiency motor versus a standard efficiency motor will pay back over a short period due to the utility savings. A table of system economics for various motor sizes and operating hours is provided in Appendix C with ECO 5 backup calculations.

TABLE 3-14 ECO 5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

#### 3.4.6 ECO 6 - ECONOMIZERS

#### Premise:

This ECO involves using outside air economizers on air handling units (AHUs) to optimize the use of "free" outside air for cooling, to maintain comfort conditions within the space, whenever possible.

## Field Survey:

AHUs were surveyed to determine outside, return, and relief air dampers and controls, including measurements or estimates of minimum ventilation rates on selected buildings.

## Basis for Analysis:

Economizers consist of controlling return air, outside air, and relief air dampers to provide "free" outside air for cooling, whenever possible. The economizer controls set the dampers to provide 100% outside air when outside air temperatures are capable of satisfying the cooling load. As outside air temperatures drop, the dampers are modulated to provide the required mixed air temperature. When outside air temperatures are above the temperature required to satisfy the cooling load, outside air is modulated to the minimum required for ventilation. The actual demand for cooling is considered in optimizing of damper controls.

The amount of energy which can be saved is limited by:

- The six month operating schedule of the cooling systems.
- Outside air temperatures during the cooling season, which are rarely cool enough to satisfy the inside cooling load.
- Operation of the economizers throughout the heating season, which will also improve occupant comfort during the heating season, when buildings often overheat, but can increase heating loads. (This analysis assumes economizer operation only during the cooling season.)

Installation of an economizer requires installation of linked return air and outside air dampers and operators, with specialized dry bulb economizer controls. In some cases, one or more of these dampers may already exist. Additional duct work may be required to bring in outside air and expel relief air. The dry bulb economizer control must be interfaced into the existing control system.

# **Energy Savings Calculations:**

The baseline condition was simulated by computer for typical buildings, using either measured or design ventilation rates. When no information was available on ventilation rates, a standard minimum ventilation rate of 20 cfm per person was used. This ECO was evaluated using the dry bulb economizer control strategy, as described above.

# 3.4.6 ECO 6 - ECONOMIZERS (Continued)

**Energy Savings Calculations:** (Continued)

**Energy Savings Calculations:** (Continued)

Economizer energy savings for the typical buildings were extrapolated to obtain savings for similar buildings, based on the following assumptions:

- An economizer should carry the same fraction of the cooling load for similar buildings.
- Similar buildings have the same cooling load per square foot of floor area.

Table 3-15 on page 3-30 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-15 ECO 6, ECONOMIZERS

 41.4	0.4	39,924	696	0	0	696	129	0	37,833	0
				(\$/yr)						
			(\$/yr)	Savings	(\$/yr)	(\$/yr)	(MBtu/yr)	(MBtu/yr)	(kWh/yr)	<u>`</u>
 (yrs)		(\$)	Savings	Energy	Savings	Savings	Savings	Savings	Savings	ings
 Payback		Cost	Annual	Non-	Demand	Energy	Energy	Gas	Electric	Jemand
 Simple	SIR	Const.	Total	Annual	Annual	Annual	Total	Annual	Annual	eak

#### 3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP

#### **Premise:**

This ECO involves controlling the hot water and DHW circulation pumps to minimize pump operation.

#### Field Survey:

Nameplate data were recorded and operating sequences were determined for the hot water and DHW circulation pumps in selected buildings. The DHW pumps run continuously all year round, but the hot water pumps run continuously during the heating season and are turned off at other times.

## **Basis for Analysis:**

Circulation pumps are used to pump conditioned water to various areas in a building. Many times during the heating season these pumps are not used, such as during unoccupied periods with night setback, or when heating loads are met by other means. During these times, they can be turned off, thereby saving energy. For the purpose of this analysis, the pump was cycled on and off according to heating demand. Space temperature setpoints were lowered during unoccupied periods (night setback mode).

Optimization controls would be installed to shut off the circulation pumps during unoccupied periods and when heating loads are met in the building. These controls would optimize the operation of the pumps by using a building occupancy schedule and space temperature sensors to determine if there is a need for heating. An outside air temperature sensor would also be included, to determine the optimum start and stop times.

## **Energy Savings Calculations:**

Electrical energy savings are the difference between the existing energy consumption (pump running continuously) and the improved energy consumption (pump cycled to meet heating demand). Boiler electrical consumption is included.

Heating energy savings will be achieved because the controls installed to cycle the pump will also be able to implement a night setback of the space temperature setpoints. These savings are the difference between the existing energy consumption (constant space temperature setpoint) and improved energy consumption (setpoint lowered during occupied periods). The following equations were used:

Pump Electric Usage

= (electric load) x (hours of operation)

Electric Savings
Gas Savings

= existing electric usage - improved electric usage

= existing gas usage - improved gas usage

Table 3-16 on page 3-33 provides an economic summary of this ECO.

# 3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP (Continued)

#### **Results:**

Annual Natural Gas Savings (MBtu) 233 Annual Electrical Energy Savings (kWh) 124,564 Annual Demand Savings (kW) 0 Annual Non-Energy Cost Savings \$0 Total Annual Cost Savings \$4,264 \$11,003 Estimated Construction Cost 15 Analysis Period (years) Simple Payback (years) 2.6 Savings-to-Investment Ratio (SIR) 4.6

Recommendation: Implement.

TABLE 3-16 ECO 7, CONTROL HOT WATER CIRCULATION PUMP

Demand		Annual	Total	Annual	Annual	Annual	Total	Const	SIR	Simple
	id Electric	Gas	Energy	Energy	Demand	Non-	Annual	Cost		Payback
Savin		Savings	Savings	Savings	Savings	Energy	Savings	<b>(%)</b>		(yrs)
(kW)		(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	Savings	(\$/yr)			
						(\$/yr)				
101	0 124,564	233	829	4,264	0	0	4,264	11,003	4.6	2.6

#### 3.4.8 ECO 8 - INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

#### Premise:

This ECO involves replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption.

#### Field Survey:

Shower and faucet flow rates on selected buildings were measured. Low-flow shower heads and faucets were then installed and the flow rates remeasured. Flow rates as high as 5.6 were measured.

# Basis for Analysis:

Standard shower heads and faucets use more hot water than necessary. The heating of this extra water increases building energy and water consumption.

## **Energy Savings Calculations:**

The energy savings was found by calculating the energy needed to heat the water for existing shower heads and faucets, and subtracting the energy required for low-flow shower heads and faucets. Water savings were calculated in the same manner.

Existing Annual Usage	=	(no. of people) x (gpm <sub>p</sub> ) x (usage time)
Low-Flow Annual Usage	=	(no. of people) x (gpm <sub>ii</sub> ) x (usage time)
Annual Energy Savings	=	(present gal per yr - low-flow gal per yr) x
		(8.33) Cp x (shower water temperature -
		supply water temperature)/eff

#### where:

No. of people	= Occupants in building
gpm <sub>p</sub>	= Present gallons per minute
gpm <sub>lf</sub>	= Low-flow gallons per minute
Usage time	= Minutes of usage per year
8.33	= lbs per gallon
Cp eff	= Specific heat of water, 1 Btu per lb °F
eff	= Efficiency of water heater; gas-70%, electric-100%
shower water	•
temperature	= 102°F
supply water	
temperature	= 66°F

Table 3-17 on page 3-36 provides an economic summary of this ECO.

# 3.4.8 ECO 8 - INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES (Continued)

#### **Results:**

Annual Natural Gas Savings (MBtu) 99 Annual Electrical Energy Savings (kWh) 0 Annual Demand Savings (kW) 0 \$550 Annual Non-Energy Cost Savings **Total Annual Cost Savings** \$1,010 Estimated Construction Cost \$925 Analysis Period (years) 15 0.9 Simple Payback (years) Savings-to-Investment Ratio (SIR) 13.5

**Recommendation:** Implement.

TABLE 3-17
ECO 8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

6.0	13.5	925	1,010	550	0	460	66	66	0		0
			(\$/yr)	Savings (\$/yr)	(\$/yr)	(\$/yr)	(MBtu/yr)		(MBtu/yr)		(kWh/yr) (
(yrs)		<b>(</b>	Savings	Energy	Savings	Savings	Savings		Savings		Savings
Payback		Cost	Annual	Non-	Demand	Energy	Energy		Gas	Electric Gas	
Simple	SIR	Const.	Total	Annual	Annual	Annual	Total		Annual		Annual

# 3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS

#### Premise:

This ECO involves reclaiming heat from hot refrigerant gas and using it for heating domestic hot water (DHW).

## Field Survey:

Data from vapor compression cooling machines and DHW loads on selected buildings was collected.

**Basis for Analysis:** 

Heat can be reclaimed from hot refrigerant gas via a refrigerant desuperheater which transfers heat from hot refrigerant gas to circulating water. The desuperheater would be installed in the hot gas piping between the compressor and condenser, where it precools the hot gas entering the condenser. Heat transfer is limited by the temperature of the hot gas, which does not normally exceed 160°F. The maximum practical water temperature which can be generated is about 140°F, ideal for DHW heating. Desuperheaters reclaim about 2,600 Btuh of heat per ton of refrigeration load in heating water from 75°F to 140°F.

The following factors influence the performance of the desuperheater:

- Refrigeration systems which operate year round will produce more hot
  water than refrigeration systems operating seasonally. Food refrigeration
  systems are ideal candidates, while space cooling systems are poor
  candidates.
- DHW loads must be substantial to justify the cost of installing a desuperheater. Office buildings are poor candidates, while food service facilities are good candidates.

Food service facilities typically have walk-in coolers with substantial refrigeration loads, and also have significant DHW loads. Buildings 133 (Fort Gillem) and 500 (Fort McPherson) are food service facilities; however, Building 500 was selected for analysis because it has a greater DHW load.

The hot refrigerant gas heat reclaim system consists of refrigerant desuperheaters on each refrigeration system, a DHW tank, a small pump, and insulated water piping. The 200-gallon storage tank is sized to store hot water generated at night when there is no consumption of hot water.

# 3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS (Continued)

# **Energy Savings Calculations:**

Building 500 is equipped with two 7.5 ton refrigeration systems serving two walk-in coolers. Assuming a 50% load factor, a desuperheater will heat 867 gallons of water per day from 75°F to 140°F. At an estimated 250 meals per day, the daily DHW usage is 600 gallons, with a DHW heating load of 286,000 Btu per day. The desuperheaters are thus capable of supplying the entire DHW load. Assuming a 75% efficiency for the existing gas water heater, the resulting annual energy savings is 139 MBtu. The desuperheater will require a small, 60-watt pump for water circulation, adding 526 kWh to the current annual electricity usage.

Table 3-18 on page 3-39 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

**Recommendations:** The best case evaluation of Building 500 indicates poor economics. Do not implement.

TABLE 3-18 ECO 9, HEAT RECLAIM FROM HOT REFRIGERANT GAS

 22.5	9'0	16,579	738	0	0	238	158	158	0	0	200
			(4/3/1)	34VIII (\$) (\$/yr)	(4/9/1)	(4/9/1)	(agingini)	(windin/yi)	(KYVIŲ)I)	(KW)	
(yrs)		<b>(</b>	Savings	Energy	Savings	Savings	Savings	Savings	Savings	Savings	
 Payback		Cost	Annual	Non-	Demand	Energy	Energy	Gas	Electric	Demand	)
 Simple	SIR	Const.	Total	Annual	Annual	Annual	Total	Annual	Annual	Peak	Bldg.

#### 3.4.10 ECO 10 - PREVENT AIR STRATIFICATION

#### **Premise:**

This ECO involves providing ceiling fans to lower warm air stratified in high bay ceilings to floor level, to be used for space heating.

## Field Survey:

Measurements of air temperatures near the floor and near the ceiling were taken in Building 512 (Fort Gillem) to determine stratification. Temperatures at floor level were measured at 65°F, while temperatures near the ceiling were about 68°F.

## **Basis for Analysis:**

The temperature stratification in a conditioned space depends upon:

- Air changes between the upper and lower portions of the space.
- Amount of insulation in the ceiling.

For the purposes of this study, the air changes between the upper and lower portions of the space were estimated at 8.4 air changes per hour (ACH), which is caused by:

- · Natural convection.
- Unit heaters in the upper portion which blow air downward.

Installing ceiling fans to increase air changes between upper and lower portions will decrease stratification, thereby lowering the temperature in the upper portion, reducing heat losses through the roof, and saving energy.

Two options for ceiling fans were evaluated:

- Blade-type industrial ceiling fans delivering about 40,000 cfm with a power consumption of 145 watts.
- Four-way fans providing a choice of destratification, exhaust, or ventilation in a single unit. Four-way fans will deliver about 40,000 cfm with a power consumption of 7,300 watts.

Blade-type ceiling fans were selected over four-way fans for further analysis, because of the lower power consumption and lower cost.

One ceiling fan is required for each 5,000 square feet of floor area. Up to 15 ceiling fans may be controlled by a manual 10 amp, 220 volt switch. Installed cost of ceiling fans are estimated at \$135 per 1000 square feet of floor area, including electrical service.

# 3.4.10 ECO 10 - PREVENT AIR STRATIFICATION (Continued)

# **Energy Savings Calculations:**

Energy savings from ceiling fans were based on computer simulation of Building 336. The baseline condition was determined by simulation the building on the computer with the upper and lower portions of the space divided into two zones; the upper zone maintained at 68°F and the lower zone at 65°F.

Ceiling fans are typically sized for about 25 ACH, which would reduce stratification to about one-third of existing levels. Air temperatures in the upper portion of the space would be reduced from the current 68°F to 66°F while the lower portion would remain at 65°F. A second model was then created by lowering the upper zone temperature from 68°F to 66°F. Annual energy savings is the difference in energy consumption between the two models. Additional electricity consumption by the ceiling fans was calculated.

Table 3-19 on page 3-42 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-19 ECO 10, PREVENT AIR STRATIFICATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
207	0	(63,948)	511	293	749	0	0	749	32,357	0.5	43.2
102	0	(8,566)	89	39	100	0	0	100	4,334	0.5	43.2
214	0	(71,495)	571	327	828	0	0	838	36,175	0.5	43.2
400	0	(32,819)	262	150	385	0	0	385	16,669	0.5	43.2
401	0	(4,283)	34	20	50	0	0	50	2,167	0.5	43.2
512	0	(51,538)	412	236	604	0	0	604	26,078	0.5	43.2
TOTAL	0	(232,650)	1,869	1,065	2,726	0	0	2,726	117,717	0.5	43.2

#### 3.4.11 ECO 11 - REPLACE STREET LIGHTS

#### **Premise:**

This ECO involves reducing lighting levels from street lights and replacing street light bulbs with higher efficiency bulbs where applicable.

## Field Survey:

A visual inspection of the street lights was performed before daylight to determine relative lighting levels. The type of lamp in each fixture was noted. During the field survey, no excessively lit areas were observed. Existing lighting levels are in the 0.1 to 1.5 footcandle range. Recommended street lighting levels are 0.5 to 2.0 footcandle range. Fort Gillem is presently operating on minimal street lighting; therefore, light reduction is not recommended. However, some existing bulbs could be replaced with higher efficiency high-pressure sodium (HPS) or metal halide bulbs.

# **Basis for Analysis:**

Replacing low-efficiency mercury vapor and quartz bulbs with higher efficiency HPS bulbs can save energy. The list below indicates the proposed bulb replacements:

Now in use	Lumens <u>per bulb**</u>	Proposed <a href="mailto:change">change*</a>	Lumens per bulb**
175 Watt Mercury Vapor	8,000	150 Watt HPS	13,000
400 Watt Mercury Vapor	20,000	360 Watt HPS	35,000
1500 Watt Quartz Lamp	35,800	400 Watt HPS	45,000
500 Watt Quartz Lamp	20,000	200 Watt HPS	19,800

Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

<sup>\*</sup> Source: <u>The Energy Saver's Guide to Good Outdoor Lighting</u>, published by the National Lighting Bureau.

<sup>\*\*</sup> Approximate vertical lumens reflect initial light output (Sylvania Large Lamp Catalog).

# 3.4.11 ECO 11 - REPLACE STREET LIGHTS (Continued)

## **Energy Saving Calculations:**

The savings realized from replacing low-efficiency bulbs with higher efficiency bulbs is calculated by:

Electrical Demand (kW) = (present bulb wattage-replacement bulb wattage) x

(number of bulbs)/1000

Energy Reduction (kWh) = (Electrical Demand x hours "ON" per year)

Hours "ON" per year = 3,285 hours

Table 3-20 on page 3-45 contains results of the analysis of this ECO.

**Results:** (Combined results for lighting with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu) Annual Electrical Energy Savings (kWh) 4,928 Annual Demand Savings (kW) 0 \$174 Annual Non-Energy Cost Savings \$300 **Total Annual Cost Savings Estimated Construction Cost** \$2,682 25 Analysis Period (years) 8.9 Simple Payback (years) Savings-to-Investment Ratio (SIR) 1.7

Recommendation: Implement.

TABLE 3-20 ECO 11, REPLACE STREET LIGHTS

Exist. Bulb	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
	0	0	0	0	0	0	0	0	0	0	0
	0	4,928	0	12	126	0	174	300	2,682	1.7	8.9
	0	263	0	1	2	0	0	2	176	9:0	26.2
	0	10'01	0	34	256	0	0	256	9,114	0.4	35.5

#### 3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS

#### Premise:

The ECO proposes to repair or modify existing HVAC controls or to install new HVAC controls in selected buildings. Only one building, Building 101, was selected for this ECO.

Field Survey:

A field survey was performed to gather information about existing operating conditions, equipment, and controls in Building 101.

Basis for Analysis:

HVAC systems with improperly operating controls are inefficient. These systems often operate when not needed, or over-condition spaces, thereby wasting energy.

Building 101:

This administration building houses areas with extensive computer and communication equipment. The HVAC system comprises a combination of AHUs and fan coil units (FCUs). The building is primarily occupied on weekdays, but some areas are occupied continuously. For FCUs in areas occupied primarily on weekdays, the proposed control strategy is to provide direct digital control to shut off the FCUs at night and during unoccupied periods. For AHUs in the computer area, the proposed control strategy is only to monitor and alarm space temperatures.

The proposed control strategy for AHUs on the 4th floor is to provide direct digital control of heat and cooling coils and shut off fans to perform night setback; also, associated pumps, chillers, and boilers would be turned off during unoccupied periods; and to reset chilled water and hot water supply temperatures.

**Energy Savings Calculations:** 

Building 101 was computer simulated to create a baseline model. This model was then modified to simulate the proposed control modifications to the building. These two models were then compared, to calculate the change in building energy consumption. The amount of this change was then used to calculate the annual energy cost savings. Six hours per year labor savings (non-energy) were estimated for a reduction in temperature-related (too hot, too cold) work orders.

Table 3-21 on page 3-48 provides an economic summary of this ECO.

# 3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS (Continued)

# **Results:**

Annual Natural Gas Savings (MBtu)	302
Annual Electrical Energy Savings (kWh)	285,187
Annual Demand Savings (kW)	57
Annual Non-Energy Cost Savings	\$127
Total Annual Cost Savings	<b>\$14,661</b>
Estimated Construction Cost	\$57,547
Analysis Period (years)	15
Simple Payback (years)	3.9
Savings-to-Investment Ratio (SIR)	2.9

Recommendation: Implement.

TABLE 3-21 ECO 12, REVISE OR REPAIR HVAC CONTROLS

57,547 2.9 3.9	14,661	127	5,852	8,683	1,274	302	285,187	25	101
Const. SIR Simple Cost Payback (\$) (yrs)	Total Annual Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Energy Savings (\$/yr)	Total Energy Savings (MBtu/yr)	Annual Gas Savings (MBtu/yr)	Annual Electric Savings (kWh/yr)	Peak Demand Savings (kW)	Bldg.

#### 3.4.13 ECO 13 - THERMAL STORAGE

#### Premise:

This ECO evaluates using thermal storage systems for reducing electric demand. Chillers could produce ice at night to be used for space cooling during daytime peak electric demand hours. Chillers could, therefore, be turned off during peak electric demand hours, thus reducing demand charges.

## Field Survey:

The field survey included collection of all necessary data to evaluate the ECO.

## Basis for Analysis:

Based on historical electrical demand data, peak post demand occurs between the hours of 1200 hours and 1600 hours on weekdays. Computer simulations of typical office buildings at the fort indicate 30% of the afternoon peak electric demand can be attributed to space cooling equipment. Since demand charges throughout the year are based on the summertime peak electrical demand, reducing actual peak summer electrical demand will reduce electrical demand costs year round.

It is proposed to install a modular ice bank thermal storage system with a dedicated chiller. The system would supplement the existing chiller. Ice would be generated between 1800 and 0600 hours to be used for cooling between 1200 and 1600 hours. The existing chiller would be used to generate chilled water during the remaining hours of the day.

#### **Utility Savings Calculations:**

Using a building simulation computer program, a baseline model for energy consumption was established for each building. A second model was created, incorporating the thermal storage system. The annual energy savings is the difference in energy consumption between the two models.

Thermal storage does not save energy; rather, it shifts electrical demand to night time, thus leveling electrical demand and reducing electrical demand charges. Energy usage is slightly increased due to additional chiller power consumption in generating chilled brine at 25°F rather than chilled water at 42°F.

Table 3-22 on page 3-50 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-22 ECO 13, THERMAL STORAGE

		-		Ē	Α	A		E	,	E S		
_	Peak	Annual	Annual	Iotal	Annual	Annuai	Annual	lotal	Const.	) YIK	Simple	
	Demand	Electric	Gas	Energy	Energy	Demand	Non-	Annual	Cost		Payback	_
_	Savings	Savings	Savings	Savings	Savings	Savings	Energy	Savings	( <del>\$</del> )		(yrs)	
	(kW)	(kWh/yr)	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	Savings	(\$/yr)			,	
_					,		(\$/yr)					
	126	(690'6E)	0	(133)	(966)	12,935	0	11,939	349,748	0.4	29.3	

#### 3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

#### 3.4.14.1 ECO 14 - Radiant Heaters

#### Premise:

This ECO involves installing radiant heaters, in place of steam or gas unit heaters, for heating of warehouses. The new heaters could save energy over the present heaters. The radiant heaters investigated are the indirect, gas-fired, tube-type, which are ceiling mounted.

## Field Survey:

Data relating to heating equipment and heating load, including insulation and infiltration were collected in selected buildings.

## **Basis for Analysis:**

Most of the energy savings from radiant heating is from reduction in indoor air temperatures. Radiant heaters provide heat to people by direct radiation from the heaters and by reradiation from the floor. At maximum operating conditions, people may feel an operative temperature of 70°F in a room with a 50°F air temperature. Less heat is lost from the building at the lower room air temperatures than would be the case with conventional heating systems, which must provide warmer room air temperatures to maintain the same comfort level. High infiltration rates in warehouses also favor radiant heating. Additional energy savings are the result of better combustion efficiency and elimination of air circulation fans.

The radiant heaters on which this analysis is based are modular 150,000 Btuh units, installed in a pattern near the ceiling. Gas piping is routed to each modular unit, along with electrical service for the draft fans. Flue gasses may be routed to common headers to minimize new roof penetrations. Each modular unit is controlled by a separate thermostat, which allows variation of operative temperature throughout the building.

#### **Energy Savings Calculations:**

Indirect, gas-fired, infrared radiant heaters were analyzed based on "Development of Radiant Heating Economic Evaluation Methods," prepared for the Department of the Army (USAREUR) under Contract No. DACA90-88-D-0022, Delivery Order 0008.

Table 3-23 on page 3-53 provides an economic summary of this ECO.

# 3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

(Continued)

# 3.4.14.1 ECO 14 - Radiant Heaters (Continued)

#### **Results:**

Annual Natural Gas Savings (MBtu) 12,860
Annual Electrical Energy Savings (kWh) 1,687,945
Annual Demand Savings (kW) 0

Annual Non-Energy Cost Savings \$0

Total Annual Cost Savings \$103,097 Estimated Construction Cost \$1,064,948

Analysis Period (years) 15
Simple Payback (years) 10.3
Savings-to-Investment Ratio (SIR) 1.3

Recommendations: Do not implement.

TABLE 3-23 ECO 14, RADIANT HEATERS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
207	0	155,626	1,329	1,860	10,175	0	0	10,175	97,930	1.4	9.6
214	0	173,993	1,486	2,080	11,376	0	0	11,376	109,488	1.4	9.6
400	0	79,870	682	955	5,222	0	0	5,222	50,259	1.4	9.6
401	0	28,618	244	342	1,871	0	0	1,871	18,009	1.4	9.6
505	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
206	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
202	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
508	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
509	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
510	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
511	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
512	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
513	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
514	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
Total	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6

# 3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

(Continued)

# 3.4.14.2 Loading Dock Seals

#### **Premise:**

This ECO involves installing loading dock seals on warehouse buildings to reduce infiltration.

#### Field Survey:

The field survey included observation of loading dock doors and the collection of data to determine the annual space heating energy usage.

#### **Basis for Analysis:**

To unload, trucks currently back up to loading docks with overhead doors. The crack between truck and door was observed to be about six inches around the perimeter of the door. This large crack contributes significantly to infiltration. The loading dock seals eliminate infiltration through the crack.

Loading dock seals consist of flexible hypalon side and head curtains, which automatically seal the crack between the truck and the door when the truck is at the dock.

## **Energy Savings Calculations:**

Detailed analysis was performed on Building 207 and results were extrapolated to other buildings.

Infiltration rates were calculated based on the ASHRAE crack method, which uses the estimated crack area, average weather conditions, building height, and wind shielding factors. For warehouses, the cracks between trucks and doors, assuming five open doors, cause about 0.5 air changes per hour (ACH) for the building, due to the doors alone.

Computer simulation was used to establish the baseline energy consumption for Building 207. Infiltration was assumed to be 1.0 ACH. The baseline model was then modified by lowering the infiltration rate to 0.5 ACH and the building resimulated. Annual energy savings is the difference in energy consumption between the baseline and modified simulations.

Table 3-24 on page 3-56 provides an economic summary of this ECO.

3.4.14	ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS
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(Continued)

# 3.4.14.2 ECO 14 - Loading Dock Seals (Continued)

# **Results:**

Annual Natural Gas Savings (MBtu)	4,234
Annual Electrical Energy Savings (kWh)	110,603
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$22,729
Estimated Construction Cost	\$113,516
Analysis Period (years)	15
Simple Payback (years)	5.0
Savings-to-Investment Ratio (SIR)	2.8

**Recommendations:** Implement.

TABLE 3-24 ECO 14, LOADING DOCK SEALS

Annual A Electric Savings Sa (KWh) (M	S <sub>2</sub>	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
5,267 202	200	7	220	1,082	0	0	1,082	5,406	2.8	5.0
10,534 403	403	- 1	439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403	- 1	439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403	l	439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403	•	439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
10,534 403	403		439	2,165	0	0	2,165	10,811	2.8	5.0
110,603 4,234	4,234		4,611	22,729	0	0	22,729	113,516	2.8	5.0

#### 3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES

#### Premise:

This ECO involves adding switches, either manual or occupancy sensor type, to reduce the operating hours of lighting.

## Field Survey Notes

The field survey team observed and noted the following conditions in each building.

Room Number - if the number was not clearly marked on the plans or near the actual room, EMC assigned a number for that room, depending on its location, and a CAD sketch of the building, including room numbers, was provided.

Number of Fixtures- total number of fixtures per room.

<u>Fixture Type</u> - brief description of lighting fixture type (i.e., fluorescent, incandescent, metal halide).

Watts per Fixture - estimated wattage per fixture.

On or Off During Survey - whether the light was on or off during the survey.

Switch Yes or No - whether the lighting has local switch(es).

Number of Switches - number of light switches.

Unoccupied, Lights "ON" - whether the lights were turned on in an unoccupied room.

<u>Good for Occupancy Sensor</u> - whether the physical configuration of the light switch and room makes it a good candidate for an occupancy sensor type light switch.

#### Basis for Analysis:

Currently, interior lighting is left on, either because no local switching is available (only circuit breakers) or because people do not turn the lights off when they leave their offices for short periods of time. Providing light switches can save energy. For the purposes of this study, two types of lighting controls were reviewed for improving light controls:

- Occupancy sensor type light switches
- Manual light switches

# 3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES (Continued)

## Basis for Analysis: (Continued)

Occupancy sensor type light switches can provide the greatest potential savings, by automatically shutting lights off in areas which are unoccupied. The configuration of the room, the location of the existing light switch, and the number of fixtures in the room determine the type of occupancy sensor which should be installed. The savings calculations were based on 19% of the lights, which would have otherwise been left on during normal occupied hours, being turned off by the occupancy sensor light switches.

For the purposes of this study, it was assumed a small office with less than four light fixtures could have occupancy sensors installed directly in place of the existing light switch. For a larger, open area, with four or more fixtures, an overhead occupancy sensor with relay controls would be required. In large, open areas with modular furniture panel systems, which currently have no switching, manual light switches would be provided for every six light fixtures. This approximates the design standards in Department of Energy Standard 10 CFR Part 435.

Savings calculations for large open areas assume lights are left on unnecessarily one extra hour per day, five days per week, because there are no lighting switches other than circuit breakers.

# **Energy Savings Calculations**

A combination of spreadsheet and computer simulations was used to estimate the power and energy savings for lighting and air-conditioning, and the additional costs for heating. The lighting savings were determined room-by-room using spreadsheets. Air-conditioning and heating savings and costs due to a reduction in lighting, were determined by computer simulation. The typical building baseline model was made, then a second model was made to simulate the reduction in lighting loads. The difference of electrical and gas energy consumptions is the electrical savings and gas costs, respectively. The results for typical buildings were extrapolated for similar buildings.

In areas where occupancy sensor controls are proposed, the following utility savings calculation method was used:

Percent Unoccupied Lights "ON" (A) = 19% - average of all buildings surveyed

<u>Hours "ON" per Year (B)</u> = The annual hours lights are "ON" is based on building occupancy schedule

# 3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES (Continued)

**Energy Savings Calculations** (Continued)

<u>Lighting kW Saved (C)</u> = The total lighting demand (kW) x (A)

<u>Lighting kWh Saved per Year (D)</u> = (B) x (C)

 $\underline{\text{Total Gas Increase (MBtu)}} = (D) x (natural gas increase energy factor)$ 

 $\underline{\text{Total kWh Saved per Year}} = (D) x (electric saving energy factor)$ 

Table 3-25 beginning on page 3-60 contains the results of analysis of this ECO.

#### **Results:**

Annual Natural Gas Savings (MBtu)	(18)
Annual Electrical Energy Savings (kWh)	47,766
Annual Demand Savings (kW)	11
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$2,277
Estimated Construction Cost	\$30,072
Analysis Period (years)	25
Simple Payback (years)	13.2
Savings-to-Investment Ratio (SIR)	1.1

Recommendations: Implement.

TABLE 3-25 ECO 15, SEPARATE LIGHT SWITCHES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (KWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
103	0	1,702	(1)	2	41	31	0	72	436	2.4	6.1
213	2	916'6	(2)	30	230	236	0	466	3,349	2.1	7.2
935	1	6,193	(12)	32	131	126	0	257	3,465	1.1	13.5
101	4	30,555	(10)	81	735	747	0	1,482	22,822	1.0	15.4
Total	11	47,766	(18)	145	1,136	1,141		2,277	30,072	1.1	13.2
400	1	1,723	(3)	3	30	54	0	85	2,417	0.5	28.6
207	3	15,020	(29)	23	250	325	0	575	15,815	0.4	30.6
505	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
506	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
202	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
208	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6

TABLE 3-25 (Continued) ECO 15, SEPARATE LIGHT SWITCHES

	-					1	
Simple Payback (yrs)	58.6	58.6	58.6	58.6	58.6	58.6	131.6
SIR	0.3	0.3	0.3	0.3	0.3	0.3	0.1
Const. Cost (\$)	29,154	29,154	29,154	29,154	29,154	29,154	2,208
Total Annual Savings (\$/yr)	498	498	498	498	498	498	<b>41</b>
Annual Non- Energy Savings (\$/yr)	0	0	0	0	0	0	0
Annual Demand Savings (\$/yr)	33	33	33	33	33	33	0
Annual Energy Savings (\$/yr)	465	465	465	465	465	465	17
Total Energy Savings (MBtu/yr)	59	59	59	59	59	59	2
Annual Gas Savings (MBtu/yr)	(8)	(8)	(8)	(8)	(8)	(8)	(2)
Annual Electric Savings (kWh/yr)	19,718	19,718	19,718	19,718	19,718	19,718	951
Peak Demand Savings (kW)	0	0	0	0	0	0	0
Bldg.	206	510	511	512	513	514	401

#### 3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE

#### Premise:

Electrical billing demand at Fort Gillem accounted for a major portion of the total electrical charges in FY91. Fort Gillem should evaluate how billing demand could be reduced through load shedding and other load shifting applications.

#### **Basis for Analysis:**

Table 3-26 on page 3-67 lists the monthly billing demand and actual demand for FY91. Figure 3-1 on page 3-68 graphically depicts the 30-minute electrical demand interval readings for a typical winter week. Figure 3-2 on page 3-69 depicts a typical summer week. The demand readings were provided by Georgia Power account representatives. The FY91 actual demand for Fort Gillem ranged from a high of 6,864 kW in August 1991 to a low of 4,800 kW in November 1990.

The billing demand is calculated from the greatest of the following three criteria:

- · Current monthly actual demand
- 95% of the highest demand during the previous June through September
- 60% of the highest demand during the previous October through May.

The billing demand during June, July, August, and September 1991, was based on the actual demand, because of high temperature and humidity periods resulting in heavy air-conditioning loads. The billing demand for October 1990 through May 1991 was based on 95% of the highest demand in the previous summer months, a system which is referred to as "demand ratchet." The billing demand was never based on the highest demand set in October through May. See Section 2.2.1 for further evaluation and explanation of the electrical rate structure.

The analysis of billing demand, and a review of the 30-minute demand readings, suggest Fort Gillem should reduce demand by various available methods during summer weekdays, from 1200 to 1600 hours. This action will reduce billing demand (95% of the highest demand during the previous June through September).

To accomplish these reductions, Fort Gillem should consider the following load reducing strategies:

- Load shedding
- Thermal storage systems
- Absorption or gas driven chiller systems
- Lighting control systems
- Power generation
- High efficiency electrical equipment.

# 3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

## **Load Shedding:**

A computer-based Utility Control System (UCS) can control various electrical loads to better manage post demand. The UCS would monitor instantaneous post demand and calculate that demand at one-minute intervals. If the UCS predicted the electrical demand was to exceed a peak value limit (target), it would shed or cycle selected loads on a prescheduled priority basis, to reduce the connected load before the actual peak exceeds the target. The UCS could be programmed to provide, for example, eight load priority levels. In the load shed software, the lowest priority level would be shed before the load in the next higher priority level. Loads shed within a priority level would be rotated automatically, to avoid any load from always being shed first. All loads shed in the highest priority levels would be restored before loads in lower priority levels.

The UCS could incorporate one or both of the following basic system types:

- · Hardwired UCS with dedicated fiber optic data transmission system
- One-way FM radio transmission UCS.

The hardwired UCS would utilize microprocessor-based remote control units (RCUs) mounted in each building or in groups of buildings located in close proximity. The electrical loads would be wired to an RCU. A central operator station at the DEH would allow for monitoring of the post demand and programming of the RCU with the required load shed parameters. A fiber optic data transmission system would be used to communicate between the RCUs mounted at buildings, the RCU mounted at the electrical substation, and the central operator station. Because of two-way communications, the equipment monitoring, temperatures, status, and other conditions could be monitored at buildings using this type of system. A typical application of this type of system is the control of building HVAC fans, chillers, pumps, and other major electrical loads.

A one-way FM radio transmission UCS would utilize a micro-processor based digital control unit (DCU) FM radio-controlled switch, designed to switch remote loads on and off in response to commands from a central operator station. The control signals for this UCS are transmitted via FM radio signals. DCUs can be field programmed with 256 individual addresses. This type of system does not have two-way communications and would not provide equipment status monitoring. However, it has the advantage of being less expensive when controlling numerous, small electrical loads which are remotely located throughout the post. A typical application of the DCU system is in controlling small air-conditioning direct expansion (DX) compressors and electric water heaters, such as that used for family housing units.

# 3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

## **Load Shedding:** (Continued)

The family housing units at Fort Gillem were surveyed and it was determined there are a total of 5 heat pump DX compressor units, with a total of 47 kW load which could be load shed on a rotating basis.

Other electrical loads which could be shed include electric water heaters, swimming pool pumps, electric clothes dryers, and electric golf cart chargers.

## **Thermal Storage System:**

Thermal storage systems can reduce electrical demand by generating a mass of cold liquid or ice during off peak electrical periods, then using this mass to meet cooling requirements during peak electrical periods.

The primary advantage of a thermal storage system is the ability to use lower time-of-day electricity rates and off-peak demand rates to produce cold liquid or ice, which can be used instead of chillers to provide cooling for HVAC equipment during peak electrical use. Fort Gillem does not have a "time-of-day" type of rate structure which can make thermal storage extremely attractive, but if the overall peak electrical demand can be reduced by shutting off chillers during peak summer periods, demand charges can be reduced for the whole year, due to demand charge ratchets.

Thermal storage systems are most effective when used with major air cooled or water cooled chiller systems. See ECO 13, Section 3.4.13, for an evaluation of thermal storage systems for Fort Gillem.

#### Absorption or Gas Driven Chiller Systems:

Absorption or gas driven chiller systems can reduce electrical demand by generating chilled water for HVAC equipment using steam, hot water, or direct fired chiller equipment, all the time, or only during peak electrical periods. This approach would reduce the electrical demand used for cooling, and may be attractive, since Atlanta Gas Light has special rate structures for summer air-conditioning natural gas usage.

Absorption or gas driven chiller systems are most effective where major air or water cooled chiller systems are in operation.

## **Lighting Control Systems:**

Automatic lighting controls can reduce electrical energy and electrical demand (see ECO 15, Section 3.4.15.1). An occupancy sensor type of control will automatically switch lighting based on the presence or absence of people in a room. When a person enters a room, the sensor automatically switches the lights on. The lights remain on as long as someone is in the room. When the room is unoccupied, the sensor automatically turns the lights off, after a few minutes of delay.

### **<u>Lighting Control Systems:</u>** (Continued)

The best applications for occupancy sensor light switches include:

- Private offices
- Restrooms
- Hallways
- Lounges
- Computer rooms
- Clerical areas

- Conference rooms
- Classrooms
- Warehouse aisles
- Storage rooms
- Copier rooms
- Loading docks

### **Power Generation:**

Peak shaving, standby, and emergency generators can be utilized to generate part of the electrical demand during peak periods, thereby reducing the demand charges. The cost for generating electrical energy using this type of equipment is normally quite high, compared to purchasing the energy from Georgia Power directly; however, the reduction in demand charges for operating the generators for a minimum number of hours during peak summer months can offset the cost to operate the generator.

A number of standby and emergency generators at Fort Gillem are candidates for this purpose, if the organization using this power source agrees to substitute generator power.

Fort Gillem may also wish to consider installing a peak shaving generator, designed either to handle a specific set of loads (e.g., chillers, motors) in one building, or connected to the facility power grid. This would be most applicable to buildings with large electrical loads, such as major chiller equipment.

High Efficiency Electrical Equipment:

Utilizing high efficiency electrical equipment in place of standard or lower efficiency sources would reduce electrical demand if this equipment operates during the peak electrical demand periods. ECOs evaluated for this study describe the possible alternatives, including:

- ECO 19, Lighting replacements
- ECO 5, High efficiency motors
- ECO 18, Exit sign replacements.

These ECOs are generally applicable to most buildings and most systems at Fort Gillem.

### Miscellaneous Systems:

Utilizing gas appliances in place of electric appliances can reduce electric demand charges, if those items are utilized during a period when the post demand is peaking. An example would be to replace existing clothes dryers with gas clothes dryers. During the field survey of personnel quarters, it was noted electric clothes dryers are provided throughout. Natural gas was available in most buildings, and could be used for replacement clothes dryers.

### **Demand Side Management:**

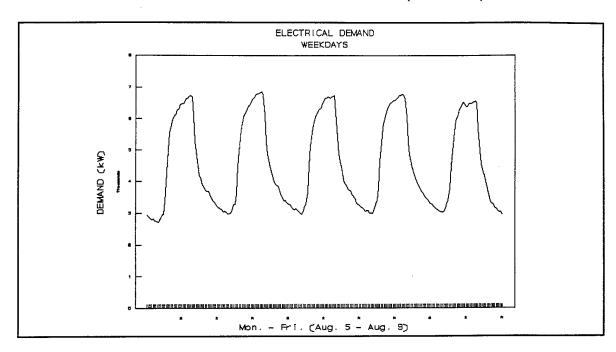
Georgia Power has submitted a plan to the State Public Utility Commission to provide "demand side management" incentives to owners for various conversions and systems operations which would reduce peak demand. This plan would provide the Government with financial incentives for all the items proposed, except for the absorption chiller system. See Section 2.5 for further discussions on the Georgia Power demand side management program.

### Sample Calculation for Reducing Peak Demand:

Table 3-27 on page 3-70 contains a sample cost per kW saved of the various alternatives presented for reducing post demand. Of the sample alternatives evaluated, occupancy sensor lighting control has the lowest construction cost per kW saved in this example.

TABLE 3-26 FY91 HISTORICAL ELECTRICAL DEMAND - FORT GILLEM

MONTH	BILLING DEMAND (kW)	ACTUAL DEMAND (kW)
Oct.	5,875	6,348
Nov.	4,800	6,348
Dec.	5,136	6,348
Jan.	5,443	6,348
Feb.	5,290	6,348
March	5,280	6,348
April	5,347	6,348
May	6,240	6,348
June	6,576	6,576
July	6,816	6,816
Aug.	6,864	6,864
Sept.	6,768	6,768



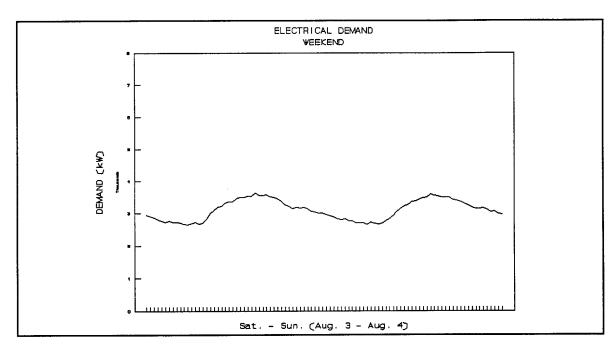
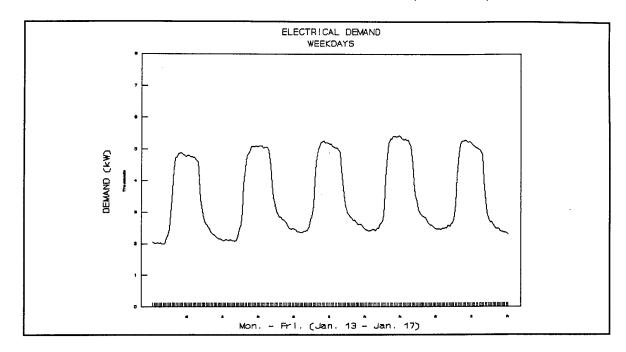


FIGURE 3-1 FY91 TYPICAL HOURLY DEMAND - FORT GILLEM SUMMER



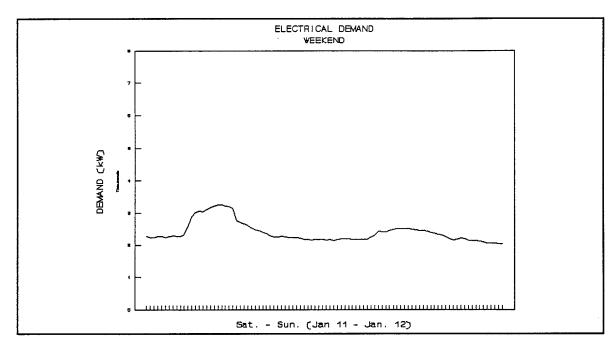


FIGURE 3-2
FY91 TYPICAL HOURLY DEMAND - FORT GILLEM WINTER

# TABLE 3-27 DEMAND SAVINGS COMPARISON

AI	TERNATIVE FOR REDUCING PEAK DEMAND	CONSTRUCTION COST (\$) PER kW SAVED
1.	One-way FM radio transmission UCS, with 108 switches, 175 kW load	420
2.	Ice storage system, 750 tons, 487 kW load	1,553
3.	Natural gas engine driven chiller, 460 tons, 300 kW load reduction	1,334
4.	Office occupancy lighting control, 0.31 kW lights	210
5.	Diesel engine generator set, 500 kW	260
6.	High efficiency electric motor, 5 hp, .81 kW saved	602
7.	Exit sign fluorescent lamp replacement kit, 10 kits, 0.3 kW saved	1,267

### 3.4.17 ECO 17 - BOILER OPERATION SCHEDULE

### Premise:

This ECO evaluates continuous, 24-hours-per-day operation of the boiler versus the current operation at 16 hours per day.

### Field Survey:

Data was collected to determine the annual energy usage of the building.

### Basis for Analysis:

Boilers in warehouses at Fort Gillem are currently shut off from 8 p.m. to 4 a.m. to conserve energy. The effectiveness of this energy conservation practice has been questioned. When the boiler is turned off, the building cools off slowly, moderated by the thermal mass of the building, which releases heat to the conditioned space. The thermal mass of the buildings is sufficient to maintain the conditioned space above freezing temperatures for the eight hours the boiler is off.

At 4 a.m., the boiler is turned back on and must satisfy the heating load of the building, in addition to reheating the thermal mass of the building. The concern is whether the amount of energy required to reheat the thermal mass exceeds the energy savings of turning off the boilers.

No equipment modifications are necessary for this ECO.

### **Energy Savings Calculations:**

Energy savings calculations were performed on Building 207. The baseline condition (16 hour boiler operation) was simulated by computer, accounting for the thermal mass of the floor, walls, and ceiling of the building. A second model was created to simulate continuous 24 hour operation of the boilers. Annual energy savings is the difference in energy consumption between the two models.

The result of the analysis for Building 207 was a 2,588 MBtu annual savings in natural gas consumption, if the boilers were shut off between 2000 and 0400 hours, and a \$12,164 savings in annual energy cost. These results were extrapolated to Buildings 505 through 514 by a ratio of UA values. Total savings is indicated in the results on the following page.

### 3.4.17 ECO 17 - BOILER OPERATION SCHEDULE (Continued)

### **Results:**

Annual Natural Gas Savings (MBtu) 21,878 Annual Electrical Energy Savings (kWh) 0 Annual Demand Savings (kW) 0 Annual Non-Energy Cost Savings \$ Total Annual Cost Savings \$102,166 Estimated Construction Cost \$0 Analysis Period (years) N/A Simple Payback (years) N/A Savings-to-Investment Ratio (SIR) N/A

**Recommendations:** Not Applicable.

### 3.4.18 ECO 18 - REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

### **Premise:**

This ECO involves replacing incandescent lamp exit signs with fluorescent bulb kits.

### Field Survey:

Exit signs were counted and typical wattage ratings obtained.

### Basis for Analysis:

It is assumed the existing exit signs are equipped with two 20 watt incandescent lamps, with an estimated lamp life of 10,000 hours. These bulbs could be replaced with a 9 watt fluorescent lamp pack, also having an estimated lamp life of 10,000 hours. No labor savings was accounted for. There would be a higher recurring cost to replace bulbs because the fluorescent lamps cost more than the existing lamps.

To accomplish the replacement, The existing exit signs must be grounded, metal framed, with incandescent bulbs. Minimum interior sign dimensions must be met.

### **Energy Saving Calculations:**

kW Savings per fixture = (Change in Watts)/1000

kWh Savings per fixture per year = (Change in Watts) x (8760 hours per yr)/1000

Increased Recurring Cost per year (\$) = ((\$7.95) - (2\*\$2.25))\*(8760 hr/10,000 hr)

= \$3.02/yr

Where: Change in Watts = Wattage of existing exit sign - Wattage of

retrofit kit

Table 3-28 beginning on page 3-74 contains the results of analysis of this ECO.

### Savings per fixture:

kW Savings per year =  $(40W-9W) \times (12 \text{ months})/1000 = 0.372 \text{ kW/yr}$ kWh Savings per year =  $(40W-9W) \times (8760 \text{ hours/yr})/1000 = 271.56$ 

kWh/yr

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MMBtu): 0
Annual Electrical Energy Savings (kWh/yr): 142,700
Annual Demand Savings (kW/yr): 16

Annual Non-Energy Cost Savings: (\$1,640)
Total Annual Cost Savings: \$3,686
Estimated Construction Cost: \$23,007

Analysis Period: 25
Simple Payback: 6.2
Savings-to-Investment Ratio (SIR): 2.5

Recommendation: Implement.

TABLE 3-28 ECO 18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
G101	2	18,396	0	69	471	216	(211)	475	2,966	2.5	6.2
103	0	2,365	0	8	61	28	(27)	61	381	2.5	6.2
202	1	12,614	0	43	323	148	(145)	326	2,034	2.5	6.2
213	1	10,512	0	36	569	123	(121)	271	1,695	2.52.5	6.2
C400	1	12,614	0	43	323	148	(145)	326	2,034	2.5	6.2
G401	1	5,256	0	18	135	62	(62)	136	8847	2.5	6.2
505	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
206	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
202	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
208	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
609	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
210	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2

TABLE 3-28 (Continued)
ECO 18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Simple Payback (yrs)	6.2	6.2	6.2	6.2	6.2	6.2
SIR	2.5	2.5	2.5	2.5	2.5	2.5
Const. Cost (\$)	1,271	1,271	1,271	1,271	339	23,007
Total Annual Savings (\$/yr)	204	204	204	204	54	3,686
Annual Non- Energy Savings (\$/yr)	(91)	(91)	(16)	(91)	(24)	(1,640)
Annual Demand Savings (\$/yr)	92	92	92	92	25	1,672
Annual Energy Savings (\$/yr)	202	202	202	202	54	3,653
Total Energy Savings (MBtu/yr)	27	27	27	27	2	487
Annual Gas Savings (MBtu/yr)	0	0	0	0	0	0
Annual Electric Savings (kWh/yr)	7,884	7,884	7,884	7,884	2,102	142,700
Peak Demand Savings (kW)	1	1	1	1	0	16
Bldg.	511	512	513	514	935	Total

### 3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW

### **Premise:**

This ECO involves the review and updating of studies prepared by both Pacific Northwest Laboratory and Stone & Webster Engineering Corporation for shared energy savings (SES) lighting retrofit projects. The feasibility of a Government-funded lighting project is also evaluated.

### Basis for Analysis:

<u>Feasibility Analysis for a Shared Energy Savings Lighting Retrofit in Building 200 at Ft. McPherson</u>, by Pacific Northwest Laboratory, January 1991.

This report determined the applicability and cost-effectiveness of an SES lighting project at Fort McPherson (Buildings 200, 246, 122, 184, 65, 358, and 170). The project proposed to retrofit the existing fluorescent fixtures with: 1) optical reflectors; 2) optical reflectors and cathode-cutout ballasts; 3) optical reflectors and electronic ballasts; or 4) to replace the existing fixtures entirely with new fixtures incorporating glare reducing parabolic louvers and cathode-cutout ballasts. The report recommended against the SES lighting retrofit project because the resulting light reduction would bring lighting levels below the minimum acceptable standards in the majority of the facilities. Based on this conclusion, this project was determined not to be feasible for Government funding.

<u>Feasibility Study for Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem, Georgia</u>, by Stone & Webster Engineering Corporation, July 1990.

This report considered the viability of an SES lighting project at Fort McPherson, Building 200 and offices, and Fort Gillem, warehouses and offices. In the office areas, the existing fixtures were recommended for replacement with new, more efficient fluorescent fixtures having approximately the same or higher illuminance levels. In the warehouse areas, the existing fluorescent system was recommended for replacement with a new, more efficient, HPS system which would deliver the same or higher illuminance levels.

Table 3-28 on page 3-78 contains the results of analysis of this ECO.

### **Energy Savings Calculations:**

In the Pacific Northwest Laboratory report, the project was determined not to be technically feasible; therefore, no further analysis was performed on the report results.

### 3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW (Continued)

### **Energy Savings Calculations:** (Continued)

Further analysis was performed on the project proposed in the Stone & Webster report. Construction costs were escalated using the Military Construction Program (MCP) to yield new energy savings at current rates.

1.3

### **Results:**

Annual Natural Gas Savings (MBtu)

Annual Electrical Energy Savings (kWh)

Annual Demand Savings (kW)

Annual Non-Energy Cost Savings

Total Annual Cost Savings

Estimated Construction Cost

Analysis Period (years)

Simple Payback (years)

0

2,971,800

1,270

\$0

\$206,159

\$226,159

\$2,380,795

A11.5

Recommendation: Implement.

Savings-to-Investment Ratio (SIR)

TABLE 3-29 ECO 19, PREVIOUS LIGHTING STUDY REVIEW

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (KWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
Office	483	1,130,220	0	3,854	28,821	49,585	0	78,405	854,1.5	1.4	1.09
Whse.	282	1,841,580	0	6,280	46,960	80,793	0	127,754	1,526,690	1.2	12.0
Total	1,270	1,270 2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

### 3.5 ECO PROJECT SUMMARY

Table 3-30 on page 3-80 lists each ECO evaluated in the Interim Submittal, along with the ECO number designation. Table 3-31, beginning on page 3-81, lists all the ECOs evaluated, listed by ECO number. The table provides the predicted annual energy savings (type and amount), annual dollar savings, construction costs (including SIOH and design costs), and life cycle economics, including SIR and simple payback.

Table 3-32, beginning on page 3-82, provides the same list of ECO results, listed in order of descending SIR.

To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$300,000, an SIR greater than 1.0, and a simple payback less than 8 years. Projects which normally do not meet ECIP criteria, but have an overall SIR greater than 1.0, are referenced as non-ECIP projects.

# TABLE 3-30 ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE 3-31 ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
2-Insulate Windows		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
3-Caulking		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
4-HW Temp		NOT APPLICABLE		- MEASUREMENT ONLY	ONLY						
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	66	66	460	0	550	1,010	925	13.5	0.0
9-Heat Reclaim		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
10-Air Stratification		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NO BUILDINGS W	JGS WITH SIR	JITH SIR GREATER THAN 1.0	HAN 1.0						
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3

TABLE 3-31
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER (CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
16-Demand		NOT APPLICABLE	ABLE								
17-Boiler		NOT APPLICABLE	ABLE								
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

TABLE 3-32 ECONOMIC SUMMARY OF ECOS, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	66	66	460	0	550	1,010	925	13.5	6:0
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	22	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
TOTAL	1,365	5,638,109	24,935	44,166	260,367	140,145	(789)	399,223	4,455,080	1.4	11.1
4-HW Temp		NOT APPLICABLE	ABLE								
1-Pipe Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER 1	HAN 1.0						
3-Caulking		NO BUILDINGS WI	IGS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
1-Wall Insulation		NO BUILDINGS WI	IGS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
2-Insulate Windows		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER 1	HAN 1.0						

# TABLE 3-32 ECONOMIC SUMMARY OF ECOS, LISTED BY SIR (CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS	ANNUAL ELECTRIC SAVINGS	ANNUAL GAS SAVINGS	TOTAL ENERGY SAVINGS	ANNUAL ENERGY SAVINGS	ANNUAL DEMAND CREDIT	NON- ENERGY SAVINGS	TOTAL COST AVOID	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
	(kW)	(kWh)	(MBtu)	(MBtu)	(\$)	(\$)	(\$)	(\$)			
9-Heat Reclaim		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
6-Economizer		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
17-Boiler		NOT APPLICABLE	ABLE								
16-Demand		NOT APPLICABLE	ABLE								
10-Air Stratification		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
13-Thermal Storage		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						

### 3.6 RESULTS

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table 3-32 on page 3-83). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total savings and costs associated with these 12 projects are:

•	Annual Electrical Savings (kWh):	5,638,109
	Annual Electrical Demand Savings (kW):	1,365
	Annual Natural Gas Savings (MBtu):	24,935
	Total Energy Savings (MBtu):	44,166
•	Total First Year Annual Utility Cost Avoidance (\$):	399,223
	Total Construction Cost (\$):	4,455,080

All ECOs which were determined to have SIRs less than 1.0 should be dropped from further analysis. These include:

- - ECO 1, Pipe Insulation
  - ECO 1, Wall Insulation
  - ECO 2, Insulated Windows
  - ECO 3, Weatherstripping and Caulking
  - ECO 6, Economizers
  - ECO 9, Heat Reclaim from Hot Refrigerant Gas
  - ECO 10, Prevent Air Stratification
  - ECO 13, Thermal Storage

### **SECTION 4.0**

### **ENERGY CONSERVATION PROJECTS**

### 4.1 PROJECT DEVELOPMENT

The individual ECOs determined to be economically viable were reviewed at the Interim Submittal review conference with the Fort Gillem DEH and the Savannah District COE, and grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Subsequent to the Interim Submittal, the Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings) at Fort Gillem. These facilities were eliminated from the possible ECIP funded projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal to be revised to take into account lower individual ECO construction cost estimates.

To qualify as an ECIP project, an ECO, or several combined ECOs, must have a construction cost estimate greater than \$300,000, a savings-to-investment ratio (SIR) greater than 1.0, and a simple payback less than 8 years. The overall project, and each discrete part of the project, must have an SIR greater than 1.0. At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

Non-ECIP projects, funded under the QRIP program, must have a construction cost estimate less than \$100,000 and a simple payback period of 2 years or less. Projects funded with MCA funds must have a construction cost greater than \$200,000 and a simple payback period of 4 to 25 years. At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1, including the following ECOs:
  - ECO 1, Add duct insulation
  - ECO 1, Add roof insulation
  - ECO 5, Install high efficiency electric motors
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 14, Infrared heaters
  - ECO 15, Separate (automatic) light switches
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits.
- MCA Project 2, previous lighting review study, for light fixture replacement.

ECO 8, which involves installing low flow shower and faucet fixtures, was evaluated as a low-cost or no-cost ECO to be performed by in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR greater 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

The results of analysis for each project are contained in the following sections. The backup calculations for these projects are provided in Appendix D to this Volume I. See Section 3.0 for details related to the evaluation of individual ECOs.

Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. It is estimated the reduction in savings is negligible.

### 4.2 ECIP PROJECTS

No projects qualified for funding under the ECIP program.

### 4.3 NON-ECIP PROJECTS

### 4.3.1 QRIP Project

No projects qualified for funding under the QRIP program.

### 4.3.2 MCA Project-1

This project involves installing a combination of several ECOs on buildings and mechanical equipment to reduce utility costs. The ECOs include:

- ECO 1, Add duct insulation
- ECO 1, Add roof insulation
- ECO 5, Install high efficiency electric motors
- ECO 7, Control hot water circulation pumps
- ECO 11, Replace street lights
- ECO 12, Revise or repair HVAC controls
- ECO 14, Infrared heaters
- ECO 15, Separate (automatic) light switches
- ECO 18, Replace exit signs bulbs with fluorescent bulb kits

ECO 1 involves reducing energy consumption by adequately insulating ductwork and roofs. Adequate insulation thickness is defined as the recommended thickness from Corps of Engineer guide specifications and ASHRAE Standard 90.1-1989. Buildings which require duct insulation include Buildings 101 and 735. Building 207 requires roof insulation.

ECO 5 involves replacing standard efficiency motors with high efficiency motors to save electrical energy and demand. Buildings appropriate for replacement of standard efficiency motors include

Buildings 101, 103, 207, 213, and 214.

ECO 7 involves turning off HW and DHW circulation pumps when they are not needed. HW pumps run continuously during the heating season. HW pumps could be shut off using optimization controls during unoccupied periods and when heating loads are met in the building. This will result in heating and electric energy savings. DHW circulation pumps operate continuously year round. Installing time clocks on these pumps could minimize operating time. Building 101 is the only building appropriate for providing hot water pump controls.

ECO 11 involves replacing twelve 1500-watt exterior quartz lamp fixtures with 400-watt high pressure sodium lamp fixtures to save energy. Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

ECO 12 involves installation of direct digital controls (DDC) in place of existing local loop controls. Many of the existing local loop controls operate poorly, over-condition spaces, and waste energy. New DDC would maintain proper temperature setpoints, reduce service calls for temperature related problems, and reduce energy consumption. Building 101 is the only building appropriate for providing DDC.

ECO 14 involves installing radiant heaters, in place of steam or gas unit heaters, for heating of warehouses. The new heaters will save energy over the present heaters due to reduction in indoor air temperatures, better combustion efficiency, and elimination of air circulation fans. Buildings appropriate for providing radiant heaters include Buildings 207, 400, and 401.

ECO 15 involves installation of occupancy sensor lighting controls. Currently, interior lighting is left on, either because no local switching is available or because people do not turn the lights off when they leave their offices for short periods of time. Providing occupancy sensor light switches can save energy. Buildings appropriate for providing separate (automatic) light switches include Buildings 101, 103, 213, and 935.

ECO 18 involves replacing incandescent exit sign light bulbs with fluorescent bulbs. This replacement will result in 272 kWh saved per year per fixture. Buildings appropriate for replacing exit sign bulbs include Buildings 101, 103, 207, 213, 400, 401, and 935.

Table 4-1 on page 4-4 provides an economic summary of MCA Project-1.

### **Results:**

Annual Natural Gas Savings (MBtu)	6,919
Annual Electrical Energy Savings (kWh)	980,382
Annual Demand Savings (kW)	86
Annual Non-Energy Cost Savings	(\$607)
Total Annual Cost Savings	\$57 <i>,</i> 327
Estimated Construction Cost	<i>\$740,</i> 529
Analysis Period (years)	15
Simple Payback (years)	11.3
Savings-to-Investment Ratio (SIR)	1.1

Recommendation: Implement.

# TABLE 4-1 MCA PROJECT-1 SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (KWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
ECO-1 Duct	0	4,596	86	54	292	0	0	292	2,040	3.0	6.9
ECO-1 Roof	0	108,540	4,109	4,479	21,957	0	0	21,957	419,503	1.2	19.1
ECO-5	11	71,225	0	243	1,816	1,102	0	2,918	37,154	1.2	12.7
ECO-7	0	124,564	233	829	4,271	0	0	4,271	898'6	4.6	2.3
ECO-12	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
ECO-14- Heat	0	263,425	2,007	2,906	16,090	0	0	16,090	166,198	1.3	10.3
ECO-15	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
ECO-18	7	63,860	0	218	1,635	748	(734)	1,649	10,296	2.5	6.2
TOTAL	98	974,092	6,671	9,994	56,008	8,843	(433)	64,418	735,360	1.1	11.4

### 4.3.3 MCA Project-2

This project, made up of only ECO 19, involves the replacement of office and warehouse light fixtures with more efficient fluorescent and high pressure sodium fixtures having approximately the same or higher illuminance levels. The savings determined by a previous study indicate the energy savings will justify the replacement cost. See <u>Feasibility Study for Lighting Shared Energy Savings Project</u>, Ft. McPherson and Ft. Gillem, Georgia for buildings to be incorporated into the project.

### **Results:**

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	2,971,800
Annual Demand Savings (kW)	1,270
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$206,159
Estimated Construction Cost	\$2,380,795
Analysis Period (years)	15
Simple Payback (years)	11.5
Savings-to-Investment Ratio (SIR)	1.3

Recommendation: Implement.

### 4.3.4 Low-Cost/No-Cost Project-1

### **Premise:**

This project, made up of only ECO-8, involves replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption. Field measurements of existing showers indicate flows as high as 4.5 gallons per minute (gpm). This rate can be reduced to 1.5 gpm. Replacing shower heads and faucets can lower natural gas, water, and sewage charges. This ECO was applicable in Building 935.

### **Results:**

Annual Natural Gas Savings (MBtu)	99
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$550
Total Annual Cost Savings	\$1,010
Estimated Construction Cost	\$925
Analysis Period (years)	15
Simple Payback (years)	0.9
Savings-to-Investment Ratio (SIR)	13.5

Recommendation: Implement.

### 4.4 NAF PROJECTS

ECOs evaluated for NAF facilities were grouped together for consideration by NAF related organizations. Table 4-2 on page 4-7 provides an economic summary of projects which should be funded by NAF facility organizations to lower utility consumptions. The summary indicates there are 2 ECOs with an SIR greater than 1.0 and a simple payback less than 8 years, for a total construction cost of \$115,416. The combined results of the best 2 ECO projects are presented below.

### **Results:**

Annual Natural Gas Savings (MBtu) Annual Electrical Energy Savings (kWh) Annual Demand Savings (kW)	3,829 178,913 9 (\$906)
Annual Non-Energy Cost Savings Total Annual Cost Savings Estimated Construction Cost Analysis Period (years)	\$22,468 \$115,416 25
Simple Payback (years) Savings-to-Investment Ratio (SIR)	5.1 4.3

Recommendation: Implement the two ECOs listed.

TABLE 4-2
NAF ECONOMIC SUMMARY

ECO-14 Seals	SAVINGS (kW)	SAVINGS (kWh) 100,073	SAVINGS (MBtu) 3,829	SAVINGS (MBtu) 4,170	SAVINGS (\$) 20,433	CREDIT (\$)	SAVINGS (\$)	AVOID (\$) 20,433	(\$)	4.5	(yrs)
ECO-18	6	78,840	0	569	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	6	178,913	3,829	4,439	22,443	924	(906)	22,461	115,416	4.3	5.1

### **SECTION 5.0**

### SUMMARY AND RECOMMENDATIONS

### 5.1 SUMMARY

### 5.1.1 ECOs EVALUATED

Seventeen ECOs were identified in the SOW to be evaluated for selected buildings at Fort Gillem. During the entrance interview conference, ECO 18 was included, to be evaluated for all buildings specified for ECO 15, lighting controls. ECO 18 involves replacing incandescent exit signs light bulbs with fluorescent bulbs. After discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results were included as ECO 19; economics are based on design, bid, and construction, direct by the Government rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

### 5.1.2 RESULTS

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table 5-1 on page 5-2). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 12 projects is \$4,455,080.

Table 5-1 on page 5-2 lists the economic summary of each individual ECO, in ECO number order. Table 5-2 on page 5-4 lists the economic summary of each individual ECO, in order by SIR.

All ECOs having an SIR less than 1.0 were dropped from further analysis. These included:

- - ECO 1, Pipe Insulation
  - ECO 1, Wall Insulation
  - ECO 2, Insulated Windows
  - ECO 3, Weatherstripping and Caulking
  - ECO 6, Economizers
  - ECO 9, Heat Reclaim from Hot Refrigerant Gas
  - ECO 10, Prevent Air Stratification
  - ECO 13, Thermal Storage

TABLE 5-1 ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS W	ITH SIR	GREATER THAN 1.0	HAN 1.0						
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDINGS W	IGS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
2-Insulate Windows		NO BUILDINGS W	IGS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
3-Caulking		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
4-HW Temp		NOT APPLICABLE	1	MEASUREMENT ONLY	NLY						
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	66	66	460	0	550	1,010	925	13.5	0.9
9-Heat Reclaim		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
10-Air Stratification		NO BUILDIN	NO BUILDINGS WITH SIR	GREATER THAN 1.0	HAN 1.0						
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	22	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NO BUILDINGS W	NGS WITH SIR	GREATER THAN 1.0	HAN 1.0						
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3
T											

TABLE 5-1 ECONOMIC SUMMARY OF ECOS, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
16-Demand		NOT APPLICABLE	ABLE								
17-Boiler		NOT APPLICABLE	ABLE								
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

TABLE 5-2 ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	66	66	460	0	550	1,010	925	13.5	6:0
7-HW Pump Control	0	124,564	233	929	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	25	285,187	302	1,274	689'8	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
TOTAL	1,365	5,638,109	24,935	44,166	260,367	140,145	(789)	399,223	4,455,080	1.4	11.1
4-HW Temp		NOT APPLICABLE	ABLE								
1-Pipe Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
3-Caulking		NO BUILDINGS W	GS WITH SIR	ITH SIR GREATER THAN 1.0	HAN 1.0						
1-Wall Insulation		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						
2-Insulate Windows		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER T	HAN 1.0						

TABLE 5-2 ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
9-Heat Reclaim		NO BUILDINGS WI	GS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
6-Economizer		NO BUILDINGS WI	GS WITH SIR	TH SIR GREATER THAN 1.0	HAN 1.0						
17-Boiler		NOT APPLICABLE	ABLE								
16-Demand		NOT APPLICABLE	ABLE								
10-Air Stratification	,	NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER TI	HAN 1.0						
13-Thermal Storage		NO BUILDIN	NO BUILDINGS WITH SIR GREATER THAN 1.0	GREATER TI	HAN 1.0						

### 5.1.3 ENERGY PROJECT DEVELOPMENT

Individual ECOs were grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings) at Fort Gillem. These facilities were eliminated from the possible ECIP funded projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal be revised to take into account lower individual ECO construction cost estimates.

At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1, including the following ECOs:
  - ECO 1, Add duct insulation
  - ECO 1, Add roof insulation
  - ECO 5, Install high efficiency electric motors
  - ECO 7, Control hot water circulation pumps
  - ECO 11, Replace street lights
  - ECO 12, Revise or repair HVAC controls
  - ECO 14, Provide infrared heaters
  - ECO 15, Separate (automatic) light switches
  - ECO 18, Replace exit signs bulbs with fluorescent bulb kits.
- MCA Project 2 ECO 19, previous lighting review study, for light fixture replacement.

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low-cost or no-cost ECO to be performed by in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR less than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Table 5-3 on page 5-7 provides an economic summary of projects which should be considered for funding. Overall, there are \$3,117,080 of potential Non-ECIP projects, and \$115,416 of potential NAF projects to fund.

TABLE 5-3
PROJECTS ECONOMIC SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON- ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
MCA Project-1	98	974,092	1/9'9	66'6	56,008	8,843	(433)	64,418	735,360	1.1	11.4
MCA Project-2	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
Low-Cost/ No-Cost ECO	0	0	66	66	460	0	550	1,010	925	13.5	0.9
NAF ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
NAF ECO-18	0	78,840	0	569	2,010	924	(906)	2,028	12,711	2.5	.6.3
TOTAL	1,365	4,124,805	10,599	24,666	179,358	140,145	(682)	294,048	3,526,544	1.6	10.6

### 5.2 RECOMMENDATIONS

- It is recommended the Army fund the construction of the two MCA projects to lower facility utility consumption, in order to meet energy reduction goals of the Department of Defense.
- It is recommended Ft. Gillem DEH complete the low-flow shower and faucet fixture project (ECO-8) in-house, using operation and maintenance money and local government staff.
- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

# APPENDIX A SCOPE OF WORK AND CONFIRMATION NOTICES

# SCOPE OF WORK FOR AN ENERGY SAVINGS OPPORTUNITY SURVEY ENERGY ENGINEERING ANALYSIS PROGRAM

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- 1. BRIEF DESCRIPTION OF WORK
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- 3. PROJECT MANAGEMENT
- 4. SERVICES AND MATERIALS
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  - 5.1 ECIP Projects
  - 5.2 Non-ECIP Projects
  - 5.3 Nonfeasible ECOs
- 6. DETAILED SCOPE OF WORK
- 7. WORK TO BE ACCOMPLISHED
  - 7.1 Evaluate Selected ECOs
  - 7.2 Perform a Limited Site Survey
  - 7.3 Combine ECOs into Recommended Projects
  - 7.4 Submittals, Presentations, and Reviews

#### **ANNEXES**

- A ENERGY CONSERVATION OPPORTUNITIES
- B DETAILED SCOPE OF WORK FT. GILLEM, GA
- C DETAILED SCOPE OF WORK FT. MCPHERSON, GA
- D EXECUTIVE SUMMARY GUIDELINES
- E LIST OF MILESTONE DATES
- F SUPPLEMENTAL LIST OF INFORMATION
- G TABLE OF REQUIRED SUBMITTALS

### 1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

- 1.1 Perform a limited site survey of selected buildings or areas to insure that any methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.
- 1.2 Evaluate selected ECOs to determine their energy savings potential and economic feasibility.
  - 1.3 Group recommended ECOs into projects for implementation as detailed herein.
- 1.4 Prepare a comprehensive report to document the work performed, the results and the recommendations.

#### 2. GENERAL:

- 2.1 Other studies performed under the EEAP have been performed at this installation. Criteria for both the study and the resulting documentation has changed since the previous study was completed. This study is intended to consider specific ECOs in buildings and areas that may have been overlooked previously or recently identified.
- 2.2 The information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study.
- 2.3 The AE shall ensure that all methods of energy conservation which will reduce the energy consumption of the installation in compliance with the Energy Resources Management Plan including those listed in Annex A have been considered and documented. All methods of energy conservation which are reasonable and practicable shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination. A list of general energy conservation opportunities to be used when evaluating specific buildings or areas is included as Annex A to this scope. This list shall be considered and the evaluation of each ECO documented in the report. This list is not intended to be restrictive but only to assure that basic and generally repetitive opportunities are addressed in the report. Some of the energy conservation opportunities may not be applicable to the specific building or area at these installations. A statement to that effect is all that is required.
- 2.4 The study shall include the energy consuming buildings or areas listed in Annex B and Annex C. Annex B contains a building/eco check list specifically for Ft. Gillem, GA and Annex C contains a building/eco check list specifically for Ft. McPherson, GA. The work in the areas may be reduced somewhat by building repetition.
- 2.5 The study shall consider the use of all energy sources. The energy sources may include electricity, natural gas, liquefied petroleum gas, bulk oil, other oil products, steam when

procured, gasoline, coal, solar, etc.

- 2.6 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 25 April 1988, and the latest revision from CEHSC-FU-P, establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects.
- 2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.
- 2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).
  - 2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

#### 3. PROJECT MANAGEMENT:

- 3.1 <u>Project Managers</u>. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.
- 3.2 <u>Installation Assistance</u>. The Commanding Officer at each installation will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract. This individual will be the installation representative.
- 3.3 <u>Public Disclosures</u>. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.
- 3.4 <u>Meetings</u>. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conference.
- 3.5 <u>Site Visits, Inspections, and Investigations</u>. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and

accomplishment of the work. The AE shall coordinate with the installation point of contact on any requirements for access to secure areas.

#### 3.6 Records.

- 3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed, and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.
- 3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.
- 3.7 <u>Interviews</u>. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.
- 3.7.1 Entry. The entry interview shall thoroughly describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:
  - a. Schedules.
  - b. Names of energy analysts who will be conducting the site survey.
  - c. Proposed working hours.
  - d. Support requirements from the Director of Engineering and Housing.
- 3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.
- 4. <u>SERVICES AND MATERIALS</u>: All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, superintendence and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.
- 5. PROJECT DOCUMENTATION: All energy conservation opportunities which the AE has

considered shall be included in one of the following categories and presented in the report as such:

- 5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than four years. For ECAM and family housing projects, the \$200,000 limitation may not apply; and in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have a SIR greater than one. For all projects meeting the above criteria, shall be arranged as specified in paragraph 2.8.1 and provided with the following documentation: life cycle cost analysis summary sheet(s), description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.
- 5.2 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be documented. The life cycle cost analysis summary sheet shall be completed through and including line 7 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs in this category, the life cycle cost analysis summary sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project, and the simple payback period shall be included in the report. Additionally, these projects shall be grouped in accordance with the requirements of the Government's representative, for one of the following categories:
- a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over \$100,000 and a simple payback period of two years of less.
- b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than \$100,000 and a simple payback period of four years or less.
- c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than \$3,000 and a simple payback period of four years or less.

The above programs are all described in detail in AR 5-4, Change No. 1.

- d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than \$200,000 and a simple payback period of four to twenty-five years.
- e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform using his resources.
- 5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they

were rejected.

6. <u>DETAILED SCOPE OF WORK</u>: The general Scope of Work is intended to apply to contract efforts for all Army installations included under this contract except as modified by the detailed Scope of Work for each individual installation. The detailed Scope of Work is contained in Annexes B and C.

### 7. WORK TO BE ACCOMPLISHED:

- 7.1 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The necessary data required for these projects may not be available, requiring the AE to visit the installation to obtain any necessary information. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-bystep progression from the first assumption to the final number. Descriptions of the products. manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data. For ECOs which would significantly affect the existing heating, ventilating, and air conditioning (HVAC) system (such as adding economizer cycles, repairing or revising HVAC controls, and thermal storage) the AE is required to run a computer simulation to analyze the system and to determine the energy savings. The computer program shall use established weather data files and may perform calculations on a true hour-by-hour basis or may condense weather files and the number of calculations in to several "typical" days per month. The AE shall submit a sample computer run with an explanation of all input and output data and a summary of program methodology and energy evaluation capabilities for approval by the Contracting Officer prior to use of the program for analysis. The A-E shall use the latest version of the Life Cycle Cost in Design (LCCID) computer program. This program is available from the BLAST Support Office located at the University of Illinois. The BLAST Support Office can be reached at 1-800-UIBLAST.
- 7.2 Perform a Limited Site Survey. The AE shall conduct a limited site survey to evaluate the ECOs in the buildings or areas listed in Annex B and Annex C. These lists are not intended to be restrictive but only to assure that these opportunities, as a minimum, are considered, discussed and documented in the report. The AE may be aware of other ECOs not included in Annex B and Annex C that will produce energy, manpower or dollar savings. These should be evaluated the same as the other ECOs. Each of the items shall be considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall obtain all the necessary data to evaluate the ECOs by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms at part of the report. All test and/or measurement equipment shall be

properly calibrated prior to its use.

- 7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraph 5.1 and 5.2. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Prefinal Submittal per paragraph 7.4.2.
- 7.4 Submittals, Presentations, and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall be prepared using Wordperfect. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, sub-sections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose. All formal presentations and review meetings will be held at Fort Mcpherson.
- 7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within. A complete and separately bound report shall be prepared for each installation.

- 7.4.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The synergistic effects of any related ECOs shall have been determined and their savings calculations adjusted accordingly. The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study (see Annex D), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) documentation for the recommended projects, and (d) appendices to include the detailed calculations and all backup material. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. The prefinal report shall also include copies of all correspondence and meeting minutes.
- 7.4.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages. An electronic copy of the final report shall be given to Savannah District. A hard copy of any original material or graphics that is not in diskette form shall also be given to Savannah District.

### ANNEX A ENERGY CONSERVATION OPPORTUNITIES

- 1. Insulation (wall, roof, pipe, duct, etc) The AE shall be provided with an asbestos survey which will identify asbestos insulation
- 2. Insulated glass or double glazed windows
- 3. Weatherstripping & caulking
- 4. Measure and record the water temperature of hot water heaters \*
- 5. Electric motors Check the adequacy of the size and efficiency of HVAC equipment with motors 10 hp or greater and provide recommendations. \*
- 6. Add economizer cycles (dry bulb) and evaluate minimum outside air levels
- 7. Control hot water circulation pump (consider OA reset and optimization controls)
- 8. Install shower flow restrictors and faucet flow resistors
- 9. Heat reclaim from hot refrigerant gas
- 10. Prevent air stratification
- 11. Reduce street lights (evaluate existing survey and provide recommendation)
- 12. Revise or repair HVAC controls \*\*
- 13. Thermal storage
- 14. Air curtains, loading dock seals, and infrared heaters
- 15. Separate switches to control lighting arrangements (consider automatic controls)
- 16. Investigate post demand usage. (Provide recommendation on ways to reduce the peak)
- 17. Evaluate boiler operation. Compare continuous 24 hour operation versus the current 16 hour per day.
- \* Investigate for all buildings that are surveyed.
- \*\* If replacement of HVAC controls for large air handling unit systems is recommended, the controls shall be revised in accordance with COE standard control panel design.

The matrices in Annex B and Annex C further delineate which ECOs are applicable to each building.

## ANNEX B <u>DETAILED SCOPE OF WORK</u> <u>ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA</u>

- 1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. Gillem, Georgia.
- 2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.
- 3. Detailed Requirements: All detailed requirements selected at Ft. Gillem for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.
- 3.1 In paragraph 3.7 "Interviews" interviews are to be scheduled at least (2) two weeks in advance by the A-E.
- 3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.
- 3.3 The Fort Gillem point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.
- 3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".
- 3.5 For this study M (as in MBTU) is 106.
- 3.6 Provide a glossary and a table of contents in all volumes.
- 3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment. The AE shall coordinate the hours of operation with the installation point of contact.
- 3.8 In paragraph 7.1 "Evaluate selected ECOs" The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.
- 4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.
- 5. Reference Documents: The Project Manager for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study to Savannah District Project Manager.

### ECO/BUILDING CHECK LIST ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
*101 (ADMIN)	х	х	х	х	х	х	х		х			х			х		
102 (MAINT)				х	х					х							
103 (FIRE STA				х	x										Х		
133 (O CLUB)				х	х				Х								
207 (STOR)	1			х	Х					х				х	х		
213 (CID BLDG				х	х										х		
214 (COMMISS)				х	х					х				х			
308 (STOR)				х	х												
400 (DOL)				х	х					х				Х	х		
401 (81st ARC				х	х					х				Х	х		
403T (DIN FAC				х	х												х
*505 (STOR)**				х	х												Х
506 (STOR)																	х
507 (STOR)																	х
508 (STOR)																	х
509 (STOR)																	х
510 (STOR)											-						х
511 (STOR)																	х
512 (STOR)	Х	Х	х	Х	х					х				Х	х		
513 (STOR)																	Х
514 (STOR)																	х
701T (ADMIN)	Х.	х	х												х		х
702T (ADMIN)	х	х	х		•										х		х
703T (ADMIN)	х	Х	Х												х		x
704T (ADMIN)	х	х	х	х	х										х		х

ECO 27 is postwide.

I Denotes that the building is temporary construction.

<sup>\*</sup> This building is secure or has secure areas that will require an escort.

<sup>\*\*</sup> Bldg 505 is typical for all the 500 block building (except 512). Only survey this typical building.

### ECO/BUILDING CHECK LIST ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

BUILDING								EC	D NUI	1BER						-	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
705T ADMIN***	х	х	Х												х		х
706T (ADMIN)	Х	Х	х												Х		Х
707T (ADMIN)	х	Х	х												х		х
708T (ADMIN)	x	Х	х												х		х
709T (ADMIN)	х	Х	х												Х		х
710T (ADMIN)	х	Х	х												Х		х
735T (CHAPEL)	х	х	х	х	х												
918T (BOWLING				х	х							**			х		
922 (ADMIN)	Х	х	х	х	х										Х		
923 (STOR)	х	Х	х	х	Х										х		
935 (FIT CTR)				х	х										х		
942T (DIN FAC				х	x	х	х		х								

ECO 27 is postwide.

T Denotes that the building is temporary construction.

<sup>\*\*\*</sup> Bldg 705 is typical for buildings 701 thru 710. Only survey this typical building.

# ANNEX C <u>DETAILED SCOPE OF WORK</u> <u>ENERGY SAVINGS OPPORTUNITY SURVEY - FT.MCPHERSON, GA</u>

- 1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. McPherson, Georgia.
- 2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.
- 3. Detailed Requirements: All detailed requirements selected at Ft. McPherson for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.
- 3.1 In paragraph 3.7 "Interviews" interviews are to be scheduled at least (2) two weeks in advance by the A-E.
- 3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.
- 3.3 The Fort McPherson point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.
- 3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".
- 3.5 For this study M (as in MBTU) is 106.
- 3.6 Provide a glossary and a table of contents in all volumes.
- 3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment. The AE shall coordinate the hours of operation with the installation point of contact.
- 3.8 In paragraph 7.1 "Evaluate selected ECOs" The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.
- 4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.
- 5. Reference Documents: The Project Engineer for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study, to Savannah District Project Manager.

### ECO/BUILDING CHECK LIST ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING								ECC	NUN C	4BER							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
022 (ADMIN)	х	х	х	Х	х			х				Х					
027 (GUEST)	х	Х	х	х	х			Х									
028 (GUEST)	Х	х	х	Х	Х			х									
040 (UPH)	X	Х	х	Х	X			Х									
041 (ADMIN)	Х	х	х	X	х										Х		
042 (CHAPEL)	Х	х	х	X	Х												
056 (UPH)				Х	Х			х				х			X		
058 (UPH)				х	х			х				х			х		
060 (UPH)				Х	х			х				х			х		
061 (LAB)	х	х	х	Х	х												
062 (UPH)				х	х			х				х			х		
100 (DENTAL)	х	х	х	Х	х												
101 (DENTAL)	Х	х	х	х	х							х			Х		
102 (POLICE)	Х	х	х	Х	Х												
105 (LAB)	х	х	х	х	х												
109T (GUEST)	х	х	Х	Х	х			X									
111 (ADMIN)	Х	х	х	х	х												
112 (ADMIN)	х	х	х	х	х												
114 (ADMIN)	Х	Х	х	х	х												
116 (ADMIN)	х	X	Х	х	х												<u> </u>
117 (CLASS RM	х	х	х	х	х												
118 (ADMIN)	х	х	х	х	X												
120 (ADMIN)	х	х	х	х	х												
121 (ADMIN)	х	х	x	х	х												
122 (ADMIN)	×	х	х	х	х												

ECO 27 is postwide.

T Denotes that the building is temporary construction.

### ECO/BUILDING CHECK LIST ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING		ECO NUMBER															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
124 (ADMIN)	х	х	х	Х	х												ヿ
126 (ADMIN)	х	x	х	х	х												
131 (CLINIC)				х	X	Х											
155 (NCO CLUB	Х	х	х	х	х												
168 (ADMIN)	, ,			х	Х			х				Х					
170 (CLINIC)				х	х	х	х		х						х		
171 (CLINIC)				х	Х	х	х		х						х		
178 (TRAINING	х	х	х	х	х												
179 (CLASS RM	х	Х	х	х	Х												
181 (ADMIN)	х	Х	х	х	х				х			х			х		
184 (STOR)	х	Х	х	х	Х	х	x								х		
187 (PX MAINT				х	Х								Х				
*200 (ADMIN)				х	х				х				х				
206 (ADMIN)				х	Х		х	-									
246 (ADMIN)				х	х	Х				-		х	х		х		
250 (LIBRARY)				х	х		-					х					
358T (ADMIN)	х	х	х	х	х	х						х					
360 (LAB)				х	х				х					х			
*363 (MAINT)				х	х										х		
366 (STOR)				х	Х					х				х	х		
400 (MOR SPT)	х	х	х	х	х										х		
401 (BOWLING)				х	х										х		
500 (DIN FAC)				х	х	х	х		х			х					
514 (DAY CARE				х	х	х											
522 (GUEST)	х	х	х	х	х				х								

ECO 27 is postwide.

T Denotes that the building is temporary construction.

\* This building is secure or has secure areas that will require an escort.

### ANNEX D EXECUTIVE SUMMARY GUIDELINE

- 1. Introduction
- 2. Building Data (types, number of similar buildings, sizes, etc.)
- 3. Present Energy Consumption.
  - o Total Annual Energy Used.
  - o Source Energy Consumption.

Electricity - KWH, Dollars, BTU

Fuel Oil - GALS, Dollars, BTU

Natural Gas - THERMS, Dollars, BTU

Propane - GALS, Dollars, BTU

Other - QTY, DOllars, BTU

- o Energy Consumption of the buildings in this study as compared to the basewide consumption.
- 4. Historical Energy Consumption.
- 5. Energy Conservation Analysis.
  - o ECOs Investigated.
  - o ECOs Recommended.
  - o ECOs Rejected.
  - o ECIP Projects Developed. (Provide list)\*
  - o Non-ECIP Projects Developed. (Provide list)\*
  - o Operational or Policy Change Recommendations.
- \* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.
- 6. Energy and Cost Savings.
  - o Total Potential Energy and Cost Savings.
  - o Percentage of Energy Conserved.
  - o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

### ANNEX E LIST OF MILESTONE DATES

	<u>Milestone</u>		Approximate Date
1.	Interim Submittal		NTP + 180 days
2.	AE receives comments on Interim Submittal	·	NTP + 218 days
3.	Interim Presentation and Review Conference		NTP + 225 days
4.	Prefinal Submittal	JULY 24, 1992	NTP + 249 days
5.	AE receives comments on Prefinal Submittal	AUGUST 7, 1992	NTP + 271 days
6.	Prefinal Presentation and Review Conference	AUGUST 20, 1992	NTP + 285 days
7.	Operational and Maintenance Briefing		NTP + 294 days
8.	Final Submittal	SEPTEMBER 4, 1992	NTP + 299 days

### ANNEX F SUPPLEMENTAL LIST OF INFORMATION

- 1. Energy Resources Management Plan
- 2. ETL 1110-3-254 dated 25 Aug 76. Use of electric Power for Comfort Space Heating
- 3. Architectural and Engineering Instructions.
- 4. Energy Conservation Investment Program (ECIP) Guidance dated 25 April 1988, and the latest revision with current energy prices and discount factors for the life cycle cost analysis.
- 5. TM 5-785 dated 1 Jul 78. Engineering Weather Data
- 6. TM 5-800-2 dated Jun 85. Cost Estimates Military Construction
- 7. TM 5-800-3 dated Jul 82. Project Development Brochure
- 8. TM 5-802-1 dated 31 Dec 86. Economic studies for Military Construction Design Applications
- 9. TM 5-815-3 dated Sep 90. HVAC Control Systems (Draft)
- 10. AR 415-15 dated 1 Jan 84. Military Construction Army (MCA) Program Development
- 11. AR 415-17 dated 15 Mar 80. Cost Estimating for Military Programming
- 12. AR 415-20 dated Jan 82. Project Development and Design Approval
- 13. AR 415-28 dated 1 Dec 81. Department of the Army Facility Classes and Construction Categories (Category Codes)
- 14. AR 415-35 dated 15 Oct 83. Minor Construction, Emergency construction, and Replacement of Facilities Damaged or Destroyed
- 15. AR 420-10 dated 3 Aug 87. Management of Directorates of Engineering and Housing
- 16. AR 11-27 dated 13 Aug 89. Army energy Program
- 17. AR 5-4, Change 1 dated 1 Aug 82. Department of the Army Productivity Improvement Program

### ANNEX G TABLE OF REQUIRED SUBMITTALS

Copies of the reports shall be submitted directly to the Agencies listed below:

AGENCY	REPORTS	EXECUTIVE SUMMARIES	FIELD NOTES
Commander Fort McPherson ATTN: AFZA-FE (Seabrook) Fort McPherson, GA 30330	4	4	. 1*
Commander U.S. Army Engineer District, Mobile ATTN: CESAM-EN-CC (Battaglia) P.O. Box 2288, Mobile, Alabama 36628-000	1** 1	1***	
Commander U.S. Army Engineer Division, South Atlant ATTN: CESAD-EN-TE (Baggette) 77 Forsythe Street, SW Atlanta, GA 30335-6801	1 ic	1	
Commander, FORSCOM ATTN: FCEN-CDI (Huff) Fort McPherson, GA 30330-6000	2	2	
Commander, HQUSACE ATTN: CEMP-ET (Torabi) Washington, DC 20314-1000		1***	
Commander, U.S. Army Logistics Evaluation Agency ATTN: LOEA-PL (Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007		1***	
Commander U.S. Army Engineer District, Savannah ATTN: CESASEN-PI-9 (Clowser) P.O. Box 889, Savannah, GA 31402	4	4	1*

- \* Required at the Interim submittal only
- \*\* Submit only the prefinal report with the final report correction pages inserted
- \*\*\* Submit after all the corrections have been made

### CONFERENCE NOTES

DATE:

18 June 1991

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

NOTICE

PREPARED BY:

Carl E. Lundstrom

EMC Engineers, Inc.

DATE OF

CONFERENCE:

14 June 1991

PLACE

DEH Conference Room, Building T-368

OF CONFERENCE: Ft. McPherson, Georgia

SUBJECT:

Pre-negotiation Meeting

ATTENDEES:

Alfred Clowser, Savannah District COE, (912) 944-5625, FAX 944-5442

Denise Williams, Savannah District COE, (912) 944-5530 Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697 Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697

Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193

Don Heldt, DEH Ft. McPherson, (404) 669-7163 B.V. Sheth, DEH Ft. McPherson, (404) 752-2071 Reg Allen, DEH Ft. Gillem, (404) 363-5270 Jim Mathis, DEH Ft. McPherson, (404) 752-3117

The following is a summary of the items discussed, the comments made, and the discussion made during the conference:

Mr. Clowser discussed the contractual portion of the work and informed EMC to deliver the submittal by UPS to 100 Oglethorp Street, Savannah, GA 31401. Mr. Clowser explained if EMC has any technical questions to talk to Denise Williams at the Savannah District COE.

Mr. Clowser explained survey periods should be coordinated with Terry Seabrook.

Mr. Lundstrom prepared a list of questions for clarification of the scope of work, as follows:

### Statement of Work, Paragraph:

All methods of energy conservation which are reasonable and practicable shall be 2.3 considered. Does this include items above and beyond Annex A?

Answer: General recommendations will be provided when EMC recognizes an opportunity.

2.10 Please explain ECAM. Does it apply to this project?

Answer: The ECAM does not apply to this project.

7.1 Discuss the number and type of computer energy simulations. Discuss acceptable computer energy simulation programs.

Answer: Par. 3.9 in Annex B & C takes precedent over par. 7.1 in the SOW on computer modeling. EMC will submit computer program descriptions along with the fee proposal.

7.2 What data is available from previous studies?

Answer: No data exists from previous studies.

### Annex B, Paragraph:

3.4 Do we need to prepare two LCCA for the two cost estimates?

Answer: The DEH has limited time to spend on site construction. EMC will prepare one LCCA, unless EMC recognizes an opportunity for a low cost/no cost ECO to be performed in-house then; in that event, two LCCAs will be prepared.

3.7 Can EMC invoice monthly for partial payments?

Answer: Yes.

3.8 Is DEH willing to supply enough blueline paper? 89 bldgs \* 25 sheets per bldg = 2225 sheets of blueline paper.

Answer: Ft. McPherson will not supply blueline machine nor paper. EMC can bring a blueline machine on post and Ft. McPherson will provide working space. Mrs. Seabrook will check on refiling of prints.

### ECO list, Paragraph:

1. Do you want EMC to identify potential asbestos insulation? Sample, test, and log? Are there any asbestos abatement project in funding cycles?

<u>Answer:</u> EMC will use Ft. McPherson's list of buildings with asbestos.

2. Do you want to consider double glazing, and various types of shaded or reflective glass?

Answer: No; insulation only.

8. Do you want us to take volt, amp, power factor, kW, kVAR, and kVA readings on each motor? Motors over 5 hp?

Answer: Yes; 10 hp and larger.

9. When we say economizer cycles, do you want EMC to evaluate modifying the HVAC systems to add duct work, dampers, and controls?

Answer: Yes; modify the HVAC systems to add duct work, dampers, and controls.

Or do you want to only modify controls on HVAC system with ducts with 100% OA and RA capability?

Answer: No.

What about evaluation of required minimum OA ventilation?

Answer: Yes; evaluate minimum OA ventilation.

10. Is HW circulation pumps referring to domestic HW or space heating circulation pumps? What type HW circulation controls do you want us to consider? Timeclocks, EMCS, OA reset and optimization controls?

Answer: "HW circulation pumps" refers to domestic HW and space heating circulation pumps. HW circulation controls will include OA reset.

11. Do you want EMC to consider tank or tankless DW heaters?

Answer: Delete from project.

12. Do you want EMC to also consider faucet flow resistors on sinks?

Answer: Yes.

17. Do you want EMC to also consider retrofitting new lamp types or fixtures?

Answer: EMC will survey and make a recommendation.

22. Do you want EMC to test all the HVAC controls to see if they need repair?

Answer: EMC will make recommendations. Buildings 101, 102, and 133 at Ft. Gillem and Buildings 65 and 184 at Ft. McPherson are removed from the project.

How do you want to handle possible controls work to be done under future shared energy savings contract, versus footnote in Annex A regarding HVAC controls to be COE standard control panel design?

Answer: EMC will perform the survey with regard to Annex A, HVAC controls to be COE standard control panel design.

26. Do you want EMC to consider ultrasonic and passive infrared automatic controls?

Answer: Yes.

27. Please expand on the description of "investigate post demand usage."

Do you want EMC to do power metering on buildings and loads? How many buildings and loads?

<u>Answer:</u> No metering. EMC will use a simple approach to evaluate and reduce post electric demand.

28. Please expand on the description of shutdown boilers versus continuous operation?

Answer: Shutdown boilers may cause higher maintenance than continuous operation.

\*\* Are all the buildings listed in the "ECO/Building Check List"?

Answer: Yes.

### Other ECOs to consider:

Steam trap ECO's, steam trap survey?

Answer: No.

#### Annex E, Paragraph:

What is the preliminary estimate of dates?

Answer: Mr. Clowser will discuss these deadlines with EMC.

### Annex F, Paragraph:

e. Do you want EMC to test boiler combustion efficiency?
 Answer: Delete from the project.

### General:

1. Are there any secure areas where we'll need escorts?

Answer: Yes; Buildings 200 and 363 at Ft. McPherson and Buildings 101, 213, and 505 at Ft. Gillem.

2. Are there any areas which will require asbestos suits and respirators?

Answer: No.

3. What type and age of hospital are buildings 170 and 171?

Answer: Buildings 170 and 171 are clinic type buildings.

Carl E. Lundstrom, P.E.

Carl & Ludstin

Confirmation No. 1

EMC #P30F.010

DATE:

24 June 1991

To/From: Denise Williams

Phone # (912) 944-5530

Representing: Savannah District, Corps of Engineers

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

NOTICE

PREPARED BY:

Carl E. Lundstrom

EMC Engineers, Inc.

SUBJECT:

Scope of Work Clarification

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 24 June 1991 between Ms. Denise Williams and Mr. Carl Lundstrom regarding clarification of the Scope of Work dated 18 June 1991 for the above referenced project.

+ Mr. Lundstrom asked Ms. Williams if she could identify the scope of work paragraph section that described the "Operational and Maintenance Briefing" listed in Annex E, item 7.

: Ms. Williams explained there was no paragraph section listing the requirements of the Operational and Maintenance Briefing; however, the briefing was meant to be a basic briefing for the maintenance staff, to be given at Ft. McPherson, to discuss the results of the study. EMC would not have to prepare any additional submittals or training material for this briefing.

Carl F Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

Confirmation No. 2

EMC #P30F.013

DATE:

8 August 1991

PROJECT:

ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)

FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

**NOTES** 

PREPARED BY:

Carl E. Lundstrom

E M C Engineers, Inc.

DATE OF

CONFERENCE:

7 August 1991

PLACE OF

**CONFERENCE:** 

U.S. Army Engineer Corps of Engineer

Savannah District Offices

Savannah, Georgia

SUBJECT:

To discuss the Scope of Work, provide clarification, and general fact

finding.

**ATTENDEES:** 

Al Clowser, Savannah District COE

Denise Williams, Savannah District COE Lucie Hughes, Savannah District COE Dick Hanna, Savannah District COE Carl Lundstrom, E M C Engineers, Inc.

Mr. Lundstrom explained the detailed fee proposal breakdown, task-by-task, explaining the approach and level of detail involved in the survey, analysis, and report writing. The attendees discussed each task. The following is a summary of the items discussed, the comments made, and the resolutions made during the fact finding conference:

- ECO 4: "Measure and record the water temperature of hot water heaters." EMC will only measure and document the domestic hot water temperatures. EMC will not evaluate any modification or change to the domestic water heaters.
- 2. ECO 6: "Add economizer cycles (dry bulb) and evaluate minimum outside air levels." EMC will not be required to take outside air (OA) flow measurements on existing HVAC systems. EMC will make engineering estimates of the OA

quantities from observations of the HVAC equipment and design drawings.

- 3. ECO 16: "Investigate post demand usage." The level of survey and analysis for this ECO will involve:
  - EMC will spend approximately one day at each site identifying potential electrical loads which could be shed, or generators which could be used to lower demand.
  - EMC will try to obtain demand information from the power company to identify the time and quantity of the peak electrical demand.
  - The A/E will provide a list of recommended ways the Fort should investigate lowering demand. No savings analysis or cost estimates will be required.
- 4. ECO 17: "Evaluate boiler operation." EMC will not be required to take any combustion efficiency tests for this ECO.
- 5. ECO project analysis, Section 7.3 of the Scope of Work: After combining ECO projects (after the interim submittal), EMC will not be required to reevaluate energy savings to take into account synergistic effects of multiple ECOs within a project and the effects of one project upon another. EMC will basically take the savings and cost estimates for ECOs directly from the interim submittal analysis and add them together to create proposed ECIP projects.
- 6. ECIP projects, Section 5.1: EMC will not be required to prepare any DD1391's or PDB's.
- 7. Non-ECIP projects, Section 5.2 of the Scope of Work: EMC will not be required to prepare any forms for QRIP, OSD PIF, or PECIP funding. EMC will only provide brief project descriptions and life cycle cost, and place the ECO in a category for non-ECIP funding.
- 8. The level of narrative text expected on the interim submittal is 40 pages, plus a few pages for a narrative summary. The final submittal will include approximately 10 more pages to describe project analysis, ECIP funding, non–ECIP funding, and executive summary.

Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately.

Confirmation No. 3

EMC #P30F.013

DATE:

8 August 1991

PROJECT:

ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)

FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

**NOTICE** 

PREPARED BY:

Carl E. Lundstrom

E M C Engineers, Inc.

SUBJECT:

Clarifications to the scope of work.

This is to confirm a telephone conversation on 8 August 1991 between Denise Williams, Savannah District COE, and Carl Lundstrom, E M C Engineers, Inc., regarding clarifications to the scope of work.

- EMC will evaluate thermal storage for Buildings 200 and 246 using computer simulations analysis. EMC at their option may evaluate thermal storage for building 187 using computer simulations or hand calculations.
- EMC will evaluate HVAC economizers for Buildings 184, 246, and 500 using computer simulation analysis. EMC at their option may evaluate HVAC economizers for the other buildings noted in Annex B and Annex C, using computer simulations or hand calculations.

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If any portion of this confirmation notice is incorrect, please notify us immediately.

Confirmation No. 4

EMC #3105.000

DATE:

21 October 1991

**To/From:** Earl Jenkins

(912) 944-5629

Savannah District COE

PROJECT:

**ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)** 

FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO.

DACA21-91-C-0097

**NOTES** 

PREPARED BY:

Carl E. Lundstrom

E M C Engineers, Inc.

SUBJECT:

Reaffirm earlier Confirmation Notices discussed with and confirmed

as accurate by Al Clowser.

This is to confirm a telephone conversation on 21 October 1991 between Earl Jenkins, Project Manager, Savannah District COE, and Carl E. Lundstrom, Project Manager, E M C Engineers, Inc.

- 1. Mr. Jenkins affirmed to Mr. Lundstrom that all the previous confirmation notices and conference notes prepared during contract negotiations are effective toward defining the scope of the project. Previous confirmation notices and conference notes include:
  - Confirmation notice 1., 24 June 1991
  - Confirmation notice 2., 8 August 1991
  - Confirmation notice 3., 8 August 1991
  - Conference notes, dated 18 June 1991

Carl E. Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

Confirmation No. 5

EMC #3105.000

DATE:

15 November 1991

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

NOTICE

PREPARED BY:

Pawn Chulavatr

E M C Engineers, Inc.

DATE OF

CONFERENCE:

14 November 1991

PLACE OF

DEH Conference Room, Building T-368

CONFERENCE:

Ft. McPherson, Georgia

SUBJECT:

**Entrance Interview** 

ATTENDEES:

Earl Jenkins, Savannah District COE, (912) 944-5622, FAX 944-5442

Denise Williams, Savannah District COE, (912) 944-5530 Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697 Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697

Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193

Jim Mathis, DEH Ft. McPherson, (404) 752-2207 Naresh Kapur, HQ FORSCOM, (404) 669-6731

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mrs. Seabrook welcomed everyone to the meeting. Mr. Jenkins introduced himself and explained the administrative portion of the project. Mr. Jenkins has replaced Mr. Alfred Clowser as the COE Project Manager. Mr. Jenkins requested that EMC show the dates of report revisions on the report covers. Mr. Jenkins requested that an extra copy of the pre-final report and the executive summary be send to the U.S. Army Engineering District, Mobile, HQUSACE, and to the U.S. Army Logistic Evaluation Agency.

Address corrections for the following agencies are listed below:

Commander
 Fort McPherson

ATTN: AFZK-EH (Seabrook) Fort McPherson, GA 30330

### CONFIRMATION NOTICE 15 November 1991 Page 2

- Commander, FORSCOM ATTN: FCEN-RDF (Kapur) Fort McPherson, GA 30330-6000
- Commander
   U.S. Army Engineering District, Savannah
   ATTN: CESASPM-MP (Jenkins)
   P.O. Box 889
   Savannah, GA 31402

Mr. Lundstrom reviewed the EMC handout and discussed the field survey, analysis, and report preparation in detail. Mr. Lundstrom explained that several ECOs may be partially funded by Georgia Power Co. EMC will investigate this concept and include it in the ECO analysis. Mr. Lundstrom asked the following questions regarding the field survey:

- Q. What steps are necessary to survey secured buildings?
- A. Mrs. Seabrook replied that Buildings 200 and 363 at Ft. McPherson and Building 101 at Ft. Gillem will require advance notice for an escort. Mr. Lundstrom will compile a building survey list schedule and coordinate with Mrs. Seabrook.
- Q. How is access obtained to secured building plans?
- A. Mr. Kapur explained that FORSCOM does not allow secure building plans to be copied. However, the plans can be visually reviewed in order to investigate ECOs. Mr. Jenkins will also check the COE files in Savannah for secured building plans.
- Q. Is there a master mechanical room key?
- A. Mrs. Seabrook will provide EMC with the necessary mechanical room keys, with the exception of the secured buildings; escort personnel will have keys for secured buildings.
- Q. Can DEH provide EMC with temporary car passes?
- A. Yes.
- Q. Will EMC be provided with shop personnel's names and telephone numbers?
- A. Mrs. Seabrook will introduce EMC to shop personnel prior to the survey.

Mrs. Seabrook requested a list of the people who will be performing the field survey. Mr. Lundstrom will provide Mrs. Seabrook with the list.

Ft. McPherson and Ft. Gillem will each receive separately bound reports.

Mrs. Seabrook requested that items be added to the building survey form (enclosed in the EMC handout). EMC will coordinate with Mrs. Seabrook.

Mr. Kapur provided an example outline of the executive summary. Mr. Kapur also discussed the following items:

- EMC should contact PNL for information on demand side management.
- ECO cost estimates should include cross-reference information and labor and material costs.
- Each ECO should include ECO descriptions and sketches. ECOs which have no energy savings should be indicated.
- More emphasis was requested on ECOs regarding lighting. (Mrs. Seabrook has previously reviewed the interior lighting ECO.)
- Before the review meeting, there should be a site walk through the representative buildings included in proposed ECOs for the project.
- Exit signs should be counted during the building survey.
- A solar lighting project should be explored.

Mrs. Seabrook stated that the exterior lighting at Ft. McPherson is being maintained by Cleo. EMC will contact Cleo for exterior lighting information.

The following reports were provided to EMC:

1 (S. Kingt

- Feasibility Study for Lighting Shared Energy Saving Project at Ft. McPherson and Ft. Gillem, July 1990.
- RFP Paid from Shared Energy Saving Projects at Ft. McPherson and Satellite Installations, August 1991.

Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

Confirmation No. 6

EMC #3105.000

DATE:

17 December 1991

TO/From: Earl Jenkins

Representing: U.S. Army Engineering District, Savannah

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

CONTRACT No.:

DACA21-91-C-0097

**NOTICE** 

PREPARED BY:

Carl E. Lundstrom

E M C Engineers, Inc.

SUBJECT:

Interim Submittal Date Change

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 17 December 1991 between Earl Jenkins and Carl Lundstrom, in which Mr. Lundstrom requested a change in the schedule date for the Interim Submittal. The new schedule date was agreed to be 30 April 1992.

Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

#### **CONFIRMATION NOTICE**

Confirmation No. 7

EMC #3105.000

DATE:

28 January 1992

To/From: Terry Seabrook

PROJECT:

**Energy Savings Opportunity Survey for an EEAP** 

Ft. McPherson/Ft. Gillem, GA

CONTRACT NO.

DACA21-91-C-0097

**NOTICE** 

PREPARED BY:

Ron Gerrans

E M C Engineers, Inc.

SUBJECT:

Adjustment to Building Energy Conservation Opportunities (ECO) List

The following is a summary of the items discussed, the comments made, and the decisions made during the meeting on 28 January 1992 between Carl Lundstrom and Terry Seabrook regarding adjustments to the building ECO list. From this meeting the following changes to the building ECO list were recommended:

- Fort Gillem: EMC will drop the following buildings from the ECO list because the buildings are scheduled for demolition:
  - Fort Gillem: 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 918, 922, 923, 942
- EMC will create a new ECO. ECO 18 will be to convert existing incandescent exit signs to fluorescent. EMC will do this for the following buildings:
  - Fort McPherson: 041,

041, 056, 058, 060, 062, 101, 170, 171, 181, 184, 200, 246, 363,

366, 400, 401

- Fort Gillem:

101, 103, 207, 213, 400, 401, 512, 935

- For ECO 1, EMC will add Fort McPherson Bldg. 360
- For ECO 6, EMC will add Fort McPherson Bldg. 181
- For ECO 8, EMC will add the following buildings:
  - Fort McPherson Bldg. 363 and 400
  - Fort Gillem Bldg. 935
- For ECO 12, EMC will investigate special HVAC control applications on Fort McPherson Bldgs. 100, 131, 170, 171, 200

#### Confirmation Notice 7 28 January 1992 Page 2

- For ECO 13, EMC will add the following buildings:
  - Fort McPherson Bldgs. 060, 170, 171, 181, 184, 363, and 500
  - Fort Gillem Bldg. 101
- For ECO 15, EMC will add Fort McPherson Bldg. 200
- In addition, we will update the technical information from the Battelle and Stone & Webster lighting surveys to analyze the possibility of a Government ECIP project instead of the proposed shared energy savings project.

Ronald M. Gerrans

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

#### CONFIRMATION NOTICE

Confirmation No. 8

EMC #3105.000

DATE:

4 March 1992

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

CONTRACT No.: DACA21-91-C-0047

NOTICE

Kamchornvuthi Chulavatr

PREPARED BY:

E M C Engineers, Inc.

DATE OF

CONFERENCE:

19 February 1992

PLACE OF

DEH Conference Room, Building T-368

CONFERENCE:

Ft. McPherson, Georgia

SUBJECT:

**Exit Interview** 

**ATTENDEES:** 

Earl Jenkins, Savannah District COE, (912) 944–5622, FAX 944–5442

Denise Williams, Savannah District COE, (912) 944-5530 Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697

Kamchornvuthi Chulavatr, E M C Engineers, Inc., (404) 952-3697

Ron Gerrans, E M C Engineers, Inc., (404) 952-3697 Jim Mathis, DEH Ft. McPherson, (404) 752-2207 Naresh Kapur, HQ FORCOM, (404) 669-6731 Gene Reardon, Chief ERMD, (404) 952-4299

Barbara ZaKrzewski, DEH Housing, (404) 752-3381 Miles Wilson, JR., Deputy DEH, (404) 752-3258 LTC C.A. McNair, JR., DEH, (404) 752-2161

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mr. Lundstrom started the meeting by described the survey effort and pointing out probable areas of energy conservation identified during the survey.

Mr. Lundstrom described the project plan for work following the survey. Mr. Lundstrom then discussed the survey findings for each ECO in detail.

Mr. Chulavatr gave slide presentation of representative buildings.

Mr. Lundstrom solicited advice from DEH to resolve the following issues concerning ECOs to be evaluated:

- Window modification on historical buildings the replacements can be double glass pane with wood frame and sash. The appearance of the new windows must be the same as the original windows.
- HVAC control the HVAC control should be evaluated based on the life cycle cost analysis of the control system. The emphasis of the control system shall be based on the cost, maintenance, ease of operation, and energy conservation capability.
- Automatic light switch Mr. Lundstrom proposed ideas for the automatic lighting control systems, which were included in the handout. The approaches were acceptable to DEH.
- Ventilation & recirculation Mr. Lundstrom proposed an exhaust fan which can perform air stratification, recirculation, and exhaust, all in one unit. This unit will be evaluated for warehouses at Ft. Gillem. The approach was acceptable to DEH.
- Reduce street lights -- Mr. Lundstrom proposed to change this ECO to replace mercury vapor street lights with high pressure sodium street lights. The approach was acceptable to DEH.

Mr. Lundstrom proposed two additional ECOs for buildings at Ft. McPherson and Ft.Gillem. The two new ECOs are:

- ECO 18 exit sign conversion
- ECO 19 incorporate lighting studies done by other A/Es for shared savings

The DEH agreed for EMC to incorporate the two new ECOs in the study, as identified in the handout.

Confirmation Notice 8 4 March 1992 Page 3

Mr. Kapur asked EMC to include a section in the report to discuss other energy conservation project considerations. Mr. Wilson commented on the manpower savings of the 4-pipe fan coil over the 2-pipe fan coil system.

Kamchornvuthi Chulavatr

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

#### **CONFIRMATION NOTICE**

Confirmation No. 9

EMC #3105.000

DATE:

6 March 1992

PROJECT:

Energy Savings Opportunity Survey for an EEAP

Ft. McPherson/Ft. Gillem

CONTRACT No.:

DACA21-91-C-0047

**NOTICE** 

**Jim Watters** 

PREPARED BY:

E M C Engineers, Inc.

DATE:

6 March 1992

SUBJECT:

Trace 600

ATTENDEES:

Denise Williams, Savannah District COE, (912) 944-5530

Jim Watters, EMC Engineers Inc. (404) 952-3697

This is to confirm a telephone conversation on the 6th of March between Denise Williams, Savannah COE, and Jim Watters, EMC Engineers, regarding the use of the Trace 600 for this project. Ms. Williams approves the Trace 600 computer simulation program.

lim Watters

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

#### **CONFIRMATION NOTICE**

Confirmation No. 10

EMC #3105-000

Date:

29 June 1992

PROJECT:

Energy Savings Opportunity Survey for EEAP

Ft. McPherson/Ft. Gillem, GA

CONTRACT NO.:

DACA 21-91-C-0097

NOTES

Carl E. Lundstrom PREPARED BY: E M C Engineers, Inc.

DATE OF

CONFERENCE:

25 June 1992

PLACE OF

CONFERENCE:

DEH Conference Room

Ft. McPherson, GA

SUBJECT:

Presentation of Findings and Interim Report Review Comments

**ATTENDEES:** 

Terry Seabrook, Installation Energy Coord., DEH (404) 752-3076

Carl Lundstrom, E M C Engineers, Inc. (404) 952-3697 Chris Stanley, E M C Engineers, Inc. (404) 952-3697

Don Heldt, Foreman, OPS Branch, DEH OOH (404) 669-7163 Buddy Rappola, Maint. Mech. Superv., DEH FESD (404) 363-5411

John Rose, Gov't Sales, GA Power Co. (404) 526-3569

Dennis Lindemeier, Proj. Mgr., Savannah COE (912) 652-5623 Denise Williams, Mech. Engr., Savannah Dist. COE (912) 652-5530 Naresh Kapur, Mech. Engr., FORSCOM Engr. (404) 669-6731

Harry H. Foster, DEH O&M (404) 752-2686

Gwen Harvey, Dist. Rep.-Gillem, GA Power (404) 362-5449 Herb Joseph, Dist. Rep.-Gillem, GA Power (404) 362-5449 Jim Mathis, Ch., Engr, Plns & Svs Div., DEH (404) 752-2207

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference:

- 1. Mr. Lindemeier introduced persons attending the meeting and gave the purpose for the review conference.
- 2. Mr. Lundstrom gave a presentation of the findings of the Interim Submittal, along with the recommendations to date.

- 3. General items discussed during a question and answer period include:
  - Mr. Heldt: The motor readings taken in Building 200 need some description to inform the reader that a majority of the motors are variable speed and that the readings are taken at a part load. Mr. Lundstrom acknowledged this concern and agreed to add clarification.
  - Mr. Kapur: Wanted to know if any exterior light readings were taken related to ECO
     11. Mr. Lundstrom explained he remembers light readings were taken, and agreed to verify this and provide light readings for the report.
  - Mr. Heldt and Ms. Seabrook: Would like to know more about the lighting control system for Building 200. There is concern about the number of telephone extensions and devices that would be required. Mr. Lundstrom agreed to provide additional catalog data for lighting control systems.

Interim submittal review comments were discussed. The following are the responses to review comments received from U.S. Army Corps of Engineers, Savannah District, and Ft. McPherson on the Interim Submittal.

#### REVIEWER: NARESH KAPUR, 4 JUNE 1992

Review Action

Item No.

# Thank you for the compliment. A, EMC tried to follow the format discussed. EMC will review descriptions and make improvements in format. Also see discussion in Confirmation Notice No. 2, item 8. A, EMC will look into the new Natural Gas rate structure and make any necessary corrections.

- 4. A, EMC will look into the water and sewage rates and make any necessary corrections.
- 5. D, the \$0.0255/kWh rate is based on low load factor, which is justified. No change.
- A, If the GA PSC decision is out by 7 July 1992, EMC will incorporate Demand Side Management credits into analysis of projects for final report.
- 7. A, EMC will try to incorporate non-energy savings where feasible.
- 8. A, EMC will reevaluate to take leakage into consideration.

- 9. A, This was not part of the Scope of Services. EMC will do a separate sample calculation for one building for Mr. Kapur directly. It is not intended to include this as part of the submittal.
- 10. A, Construction cost figures were obtained from 1992 "Means." Non-energy savings are very hard to quantify. EMC will reverify costs.
- 11. A, 0.0's will be replaced with blanks or NA.

A, Concur. Will correct.

14.

12. A, EMC will discuss with DEH any projects they feel can be done in-house.

#### **REVIEWER: WILLIAMS, 8 JUNE 1992**

Item No.	Review Action
1.	A, Concur. Will correct.
2.	A, Concur. Will correct.
3.	A, Concur. Will correct.
4.	A, Concur. Will correct.
5.	A, Buildings were inadvertently left off list. Will correct.
6.	A, Building 100 was adequately insulated. Savings factors were calculated by removing insulation from Building 100 and resimulating.
7.	A, Concur. Will correct.
8.	A, Concur. Will correct.
9.	A, Concur. Will add.
10.	A, .8 gpm per 10 tons is a factor from the Table on page C-9.3 which is used to obtain a 65°F temperature rise. Will clarify.
11.	A, Btu figure is from computer simulation for Building 207. Will clarify.
12.	A, Concur. Will correct.
13.	A, Concur. Will correct.
4.4	A. C. MAPIN AND ALL

15. A, The increase is actually a savings. Wording will be changed to clarify.

16. A, Concur. Will correct.

17. A, See Item No. 10.

18. A, Calculations are contained within spreadsheet. This is just a sample calculation. Will clarify calculation as per Item No. 11.

19. A, We will attach references. The spreadsheet calculations follow the format of the energy consumption calculations on Pages C-14.2.5 - C-14.2.8.

#### **REVIEWER: TWITTY, 15 JUNE 1992**

#### Item No. Review Action

- 1. A, The correct construction cost is \$172,912. There was a wrong number in the table that will be corrected. No change in payback.
- A, This cost is due to the size of the building and the complexity of the control system. We will look further into the control system and connections to the existing EMCS system. The occupancy sensors described on pages 3-63 and 3-64 are designed to replace existing light switches.

#### REVIEWER: JOSEPH, 25 JUNE 1992

<u>Item No.</u> <u>Review Action</u>

Regarding Table 3-26, on page 3-67

D, The correct reference is page 3-76. The columns are correct. No change.

#### REVIEWER: SEABROOK

#### Item No. Review Action

- 1. A, Will add legend to all pages.
- 2. A, Will correct building numbers.
- 3. A, Will correct.

- 4. A, Will revise.
- 5. A, Will add LCCA summary.
- 6. D, Defer comment to Savannah District. Mr. Lindemeier will prepare milestone dates for completion of the project.
- 7. A, Will add.

#### **REVIEWER: HELDT/FOSTER**

- 8. A, Will correct table.
- 9. A, Will clarify.
- 10. A, Will review, correct, and clarify.
- 11. A, Will review, correct, and clarify.
- 12. A, Will correct recommendations.
- 13. A, Will correct errors in Table.
- 14. A, Will add clarification.
- 15. A, Will correct figure.
- 16. A, Will add heading to columns.
- GEN. A, Will correct Table of Contents for Appendices.

Carl E. Lundstrom, P.E.

Project Manager

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

#### **CONFIRMATION NOTICE**

Confirmation No. 11

EMC #3105-000

Date:

29 June 1992

PROJECT:

**Energy Savings Opportunity Survey for EEAP** 

Ft. McPherson/Ft. Gillem, GA

CONTRACT NO.:

DACA 21-91-C-0097

**NOTES** 

Carl E. Lundstrom

PREPARED BY:

E M C Engineers, Inc.

DATE OF

CONFERENCE:

2 July 1992

PLACE OF

**DEH Conference Room** 

CONFERENCE:

Ft. McPherson, GA

SUBJECT:

To Identify Non-appropriated Fund Facilities

This is to confirm a meeting with Terry Seabrook and Tom Baldwin of the Ft. McPherson Directorate of Engineering and Housing, and Carl Lundstrom of EMC Engineers, Inc. The following is a summary of the items discussed, the comments made, and the decisions made.

1. The following buildings are not to be included in energy projects developed for ECIP funding, because they are NAF facilities which pay for their own utilities:

#### Ft. McPherson:

- Bldg 155, NCO Club
- Bldg 360, Commissary
- Bldg 500, Dining Facility

#### Ft. Gillem:

- Bldg 133, Community Center, Club
- Bldg 214, Commissary
- Bldg 505 through 514, Warehouses (AAFES)

- 2. Mr. Baldwin explained the following buildings at Ft. McPherson will be torn down shortly to accommodate the construction of a new medical facility. These buildings should not be included in energy projects development:
  - 116, Administration
  - 117, Classroom
  - 118, Administration
  - 120, Administration
  - 121, Administration
  - 122, Administration
  - 124, Administration
  - 126, Administration

Carl E. Lundstrom, P.E.

Project Manager

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

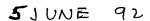
Project Review Comments: Energy Savings Opportunity Survey (ESOS) Forts McPherson/Gillem

Reviewed by: SEABROOK

Item_No.	<u>Paragraph_No.</u>	Comments	ACTION
			ACTION
1	Pg E-5 Ft Mac	Table E5.3 - Building ECO Matrix shall include legend on all pages.	A - Added legend to all pages of table.
2	Fg 3-49 Ft Mac	Correct building number in Field survey listing.	A - corrected building no's
3	Pg 3-3 Ft Mac	Add ECO 10 & 17 to Table 3.2 (Nonfeasible ECOs)	A - Added ECO's to table 3.2.
4	Pg 3-55 ECO 12 Ft Mac	Bldgs 131, 168, 170 & 171 Revise or Repair HVAC Controls - These buildings do not have boilers. They use steam,	A - Changed reference from boiler to converter, and cored numbers.
5	Appendix C-7 Ft Mac	Where is the Life Cycle Cost Analysis.	A - Added LCCA Sheet for ECO 7
6	E1 Both Forts	List Milestone Dates as Real/Actual Dates	A - Added dates from letter received from cont. officer.
7	Gen	Life Cost Analysis Summary Investment – Where is 1F ar 3B.	30 June 1992  nd  A - Changed 1F  to 1E on sheets.  3B is not used.
Heldt/Fo	ster		This is a gov't provided program.
8	Pg 3-11 Ft Mac	Occupancy for Bldg. 200 is in error.	A - Corrected schedule on page
9	Pg 3-49 Ft Mac	Error in building. Flease clarify.	A - Added clarif- cation.

Project Review Comments: Energy Savings Opportunity Survey (ESOS) Forts McPherson/Gillem

<u> Item No.</u>	<u>Faragraph_No.</u>	Comments	ACTION
Heldt/Fos	ter		
10	Pg 3-56 Ft Mac	EMCS is already staging units off line during unoccupied periods.	A - Additional clarification provided.
11	Pg 3-59 Ft Mac	Do not undertstand entry for Bldg. 200. Explain.	WD
12	Pg 3-60 Ft Mac	"Recommendations" - ?	A - Recommendations provided.
13	Pg C5.5 C5.6 C5.11/C5.12	Many errors in readings and specs. Subject to question. Use of variable frequency drives not discusse. Explain.	A - Errors corrected. Economy of variable speed drives provided.
14	Pg C12.16 Ft Mac	Do not understand at all Explain.	A - Additional clarification provided.
15	Pg C13.3 Ft Mac	Schematic not correct.	A - Schematic corrected.
16	Fg C15.1.6 Ft Mac	Explain calculations.	A - Calculations clarified.
SEABROOK	Gen	Volume II Appendix E conflicts the Table of Contents. See Appendix F.	A - Corrected Table of Contents.



FCEN-RDF

MEMORANDUM FOR COMMANDER, US ARMY ENGINEERING DISTRICT, SAVANNAH, ATTN: CESAS-PM-MP/MR. EARL JENKINS, 100 W. OGLETHORPE AVENUE, SAVANNAH, GA 31402

SUBJECT: Energy Saving Opportunity Survey for an EEAP, Fort McPherson/Gillem, GA

- 1. We received two copies of Volume I, Interim Submittal, Executive Summary, Appendices A-D of the subject energy study from EMC Engineers Inc. Our review comments are enclosed. We are very impressed with EMC Engineers efforts and responsive attitude despite difficulties involved in conducting an EEAP study.
- 2. Please let us know when a meeting to discuss the review comments and EMC Engineers' response is scheduled. Mr. Kapur, COMM 404-669-6731, can provide you additional information on the subject matter.

FOR THE ENGINEER:

Encl

RONALD D. BENTSEN Chief, Resources Division

MFR: Due to other commitments, we are a little behind on providing review comments to Savannah Dist.

RELEASED BY	
CCIPCMTM Stoudenmir	re Date
Bentsen	Date
that will mail  KSAP, If he is  prove, we can  to him, He san	the Seview in a bound TAX lie
to him. He sa	ノ

	FORSCOM	ECIP REVIEW COMMENTS DATE: 6/4/92 PG	1/2
		RGY SAVING OPPORTUNITY SURVEY, FT MCPHERSON/GI	
		RESH KAPUR, PE, FCEN-RDF, TEL: 404-669-6731/FA	
ITEM	PARA# PAGE#	ACT	IEW ION
1.	Gen	The following comments are related to Ft McPh but the same comments should be considered fo Gillem as applicable. AE HAS DONE ACCOMMENDA NO	r Ft
2.	Gen		and ches, - Added current
3.	2.2.2 2-2		ment; ake or are arm use as much - Obtained new ates from AGL. Used
4.	2.2.3 2-3	and Gillon	vised rates. - Revised rates.
5.	2.5.2	Average energy charge used is 0.0255/Kwh. Does it assume all energy reduction in high I factor block? Can this be justified?	Load D.
6.	2.6 2-10	or	- GA PSC decision n 7/7/92 had no nfo related to this
7.	3.4	ECO Analysis. Cosider non-energy savings wherever possible. Example: New surface provided by wall insulation may need less maintenance and upkeep for some time.	- Labor savings ided to ECO 12 ee App C and D.

INTERIM SUBMITTAL PAGE 5 OF

	FORSCOM	ECIP REVIEW COMMENTS DATE: 6/4/92	PG-21/2
PROJ	JECT: ENE	RGY SAVING OPPORTUNITY SURVEY, FT MCPHERS	SON/GILLEM
	EWER: NAJ	RESH KAPUR, PE, FCEN-RDF, TEL: :404-669-	-6731,
ITEN NO.	- 0	COMMENT  In the ECO, do we recognize leakage	REWIEW ACTION A - Added leakage
•	3-17	of conditioned air as a source of energy waste? If so, AE should consider fixing leakage as part of the ECO.	to insulation calculations
9.	3.4.2 3-23	Consider Window Quilts for insulation and comfort. Addl info available with Mr. Kapur. Fort Drum used it recently.	A - An example calculation for window quilts
10	3.4.3 3-30	Weatherstripping and caulking. PB is high. AE is requested to recheck const cost figures and possible non-energy savings due lower annual maintenance cost. In the current guidance, 100% nonenergy savings are allowed in Econ omic analysis. Mr Kapur has the info.	was provided sep. from report/study.  A - Costs were checked against cost estimate guides. Further clarification was added to the
11.	4.1 4-3	In different tables, SIR or PB value of 0.0 is misleading. AE may consider lessing it blank or using NA etc.	report.  A - Tables were revised to show blanks.
12.	Gen	Wherever PB of an ECO is more than 8 years, AE is requested to check if inhouse accomplishment can provide desirable payback.	A - McPherson does not feel it has adequate staffing to accomplish ECOs except as noted for low cost/ no cost ECOs

PROJECT COMME	NTS Date: 8 Jun 1992	Page 1 of 2
Site(s): Ft.   FY: 1992 LI: 2006000	gy Savings Opp. Survey  To: EMC Engineers McPherson, GA  Thru: EM-D/Lupton Thru: EM-DF/Hughes	ier ,
10% Subm	ittal Pre-Final Submittal Custom Submittal Final Submittal Corres	ted Comments er Comments porderne
tem Refer	Connent	Action
1. General	The payback should be as shown on the LCCA sheet. The payback shown on the summary tables is different.	Λ - Paybacks corrected.
	Volume 1 of Ft. McFherson study	
5. ba E2-5	Indicate that ECO 4 is only to record water temperatures and does not involve calculations.	A - Note added to Table to indicate measurement only.
3. pg ES-4	Add ECO 17 to the list of non-feasible ECOs.	A - Added ECO to Table.
4.	Tables ES.2 and ES.3 do not agree. Some ECOs that are shown as not applicable on Table ES.3 are not listed in Table ES.2 (ECO 5 for example). Also ECO 1 is shown as not applicable for some buildings but some parts of ECO 1 (pipe insul.) was applicable.	A - Made corrections to Tables to fix differences in ECOs 1 and 5
5. pg 3-11	Buildings 40-42 were not simulated. Are they similar to some other buildings? How was the energy savings determined?	A - Clarification added.
6. pg 3-15	This table shows energy savings for ECO 1 (wall and roof) for buildings 111-126 but the simulation for building 100 which is typical for these buildings does not show any savings.	A - Clarification added to computer simulation summaries Appendix C-20.
7. pg 3-22	Bldg 114 has a SIR of 0.6 and should not be included.	A - Table corrected.
8. pg C-5.	ECO-5 should be evaluated based on 25 years.	A - LCCA corrected.
9. pg 6-7.	The LCCA sheet was not included.	A - LCCA added for ECO.
10. pg C-9.	Document in your assumptions the 0.8 gpm figure used in calculating the pump size.	A - Clarification added.
11. pg C-10.2	The calculations for ECO 10 is not clear. How was the 5,960,000 Bruh figure derived. I did not see a computer simulation for this building. Please clarify this ECO and clearly state all assumptions made.	A - Sample calculation added. 5,960,000 Btuh figure deleted from calc.
	Volume 1 of ft. Uillem study	
12. pg Es-2	Same as comment #2.	A - Note added Table to indicate
13 pg ES-3	Add ECO 5 to buildings 401 and 403; and explain why they are not feasible.	measurement only.  A - ECO 5 added to Table for 401 & 403

			PAGE / UF 8
PROJ	ECT COMMI	ENTS Date: 8 Jun 1992	Paga 2 of 2 I
Proje	éct: Ene (s): Ft.	rgy Savings Opp. Survey To: EMC Engineers McPherson, GA From: EN-Drywillia:	s Inc.
	_10% Subr _Concept	SubmittelFirst SubmittelCorrect	ated Comments mer Comments spondence cted Final
tem	Refer	Comment	Action
14.	pg 3-8	This narrative does not show the buildings that were analyzed at Gillem.	A - Corrected narrative.
15.	pg 3-71	This page indicates no energy savings but the following page indicates saving. Please clarify.	A - Clarification provided.
		ECO-5 should be evaluated based on 25 years.  Document in your assumptions the 0.8 gpm figure	A - Revised LCCA for 25 years.
		used in catcutating the pump size.	A - Clarification added.
18.	pg C-10.2	Where are the calcs for buildings on page C-10.17. This calculation is for a building at McPherson. Please clarify this ECO and clearly state all assumptions made.	A - Sample calculation corrected. Calculation is for a building at Gill
19.	pg C-14.5	What are references 4, 5, 6, & 8 mentioned on this page? Where is the sample calculation for this ECO?	A - References provided. Sample calculation added.
		•	



				TAGE O OF	U
PROJECT COMM	ENTS	ate: 15 June 1992	Page 1 of 1	· t	
Project: Ene Site(s): ft. FY: 1992 L1: 2006000 CN:	rgy Savings Opp. Survey McPherson, GA T	To: ENC Engineer: hru: PM-MP/Lindem hru: EN-D/Lupton hru: EH-DF/Hughes rom: EN-DF/Iwitty	s Inc.		:
10% Subr	ion Report Preliminary Subm mittal Pre-Final Submit Submittal Final Submittal	ittel Armot tal Custon	ated Comments mer Comments		
Item Refer	Connent	and the second s	Action		
	Volume I of Ft. McPherson study		ACCION		
1. pg 3-36	The total construction cost show The correct figure should be 162 change the payback.	n is \$172,912. ,913. This will		ed motorasavings and comanufacturer.	sts.
2. pg 3-69	\$220,706 is a lot of money for l for one building. Is it possibl lighting contols in this buildin existing building DDC system or sensors as described on pages 3-	e to tie the g into the	A - Revis manufactu	ed costs obtained from rer.	



June 25, 1992

Ms. Terry R. Seabrook Department of Army HQ Fort McPherson DEH Bldg. 358

Fort McPherson, GA 30330-5000

RE: Energy Savings Opportunity Survey

Dear Ms. Seabrook:

I have reviewed the above referenced material as requested. It is a very thorough report and appears to be technically sound. I would like to examine some of the detailed calculations as time did not permit me to do so.

Below are notes of interest for your review:

°Demand savings may not be realized until billing demand ratchets run their course.

INFO ONLY

°All demands on equipment may not be coincident and therefore savings may not be a combination of selected ECO projects.

INFO ONLY

°Table 3-26 on page 3-67 has "Billing and Actual Demands" reversed.

3 PAGE 3-76 THE SAME, NO CHANGE.

As we discussed earlier, opportunity exists to control demand and, to a lesser degree, energy with demand control computerized equipment. We also can look at different rate applications that may benefit Fort Gillem. I have also enclosed a copy of the energy efficiency programs offered by Georgia Power.

If you have questions, please do not hesitate to call me or Gwen Harvey at 362-5546. I look forward to discussing this information on the morning of June 25.

Sincerely,

Herbert Joseph

#### CONFERENCE PARTICIPANTS

PROJECT LA	SAY S	Mintes 8	DEDALTING S	Colon (too)
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CARL LUNDSTR		And the second		(404) 952-3697
BUPPY RAPPOL				
PAWN CHULAVA	ATPR ENG	INEER EMO	ENGINEERS INC	(404) 952-3697
DON HEL		NS BR	DEH	(404) 669-7163
MANUEN HES			AFZK-EH-O	404-752-445
DENISE WILL			CESASEN-DE	
DIM MAT			DET	752-2207
NARESH KA			HQ FORSCOM FCFN-RDF FT. UCHERSON	404-669-6731
HE CALL	KUMK	1-851	10.2010 1-200	742-2161
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Andrew Comments				· · · · · · · · · · · · · · · · · · ·
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PROTECT: ESOS FORT MCPHERSON/ GELLEM. GA.

REVIEWER: NAKESH KAPUR. PE 404-669-6731

NOTES: Comments are for Ft McPherson study.

Also applicable to some Ecos at critical

TEMP PARA

COMMENT

REVIEW

ACTION

App. C.; C. N.4 -> C.N.8 agreed to provide Light level readings ACTION RESURED

DON 100 ES-10/11 for Court Court, Amuel saving, Annual
TIPLES IS TO PE

COSTS. is repeated.

3. General Write a 1 or 2 Page wrap up letter to Garrison Cdr explaining in layman's Executive Sulkhay terms item like Ecos recommended Total Cast, Total savings, Pay Bouch/ Return on investment etc. What are

The bruggested priorities/sequence of accomplicating there. Which enes should be done 1/4. This is not for the report but for presentation purpose.

FOUNDE SOME as associated with fixing the leabage distribution to Chiffee as part of this Eco. Cost Increase DESCRIPTION To CHIFFEE IN the enclosed Table anseds to be explained.

THESE INCREASES WERE THE RESULT OF FACTORING BY Z

A.

2/3

FORSCOM EBAP REVIEW CMT
ESOS FORT MCPHERSON/GILLEM GA
FORSCOM Supr. Mr Knymr 404-669-6731

ITEMA

PARA

COMMENT

ACTION ACTION

COMMENT W 3-23
ECO WRITE-UP TO

BE MODIFIED TO REFER READER TO AN APPENDIX FOR OTHER ADDITIONAL

3-4-11

WILL REVISE CALCULATIONS PB 13.2. Can you calculate PB based on differential Cost basis only. Change becommendations accordingly. Does then ECO consider of the Motors are Variable speed on Hours of operation?

15 there difference in life (hrs.) of different light bulbs . Would That result in Non-energy savning (t.).

CHECK CANCULATION METHODINARY (LEAGUE) TO BE CERTAIN LEAKAGE GOES DOWN (AS CLOSE TO ZERO AS ROSSIBLE). X

4.

	<b>,</b>	100 SEP 100 SEP 100 SEP	egration (1995) Segration (1995)		010		13 sts 1841.	[3/2]		17/5c		Now .			
		entw	Simple Payback (yrs)	7	4.1	4.1	4.1	1.61		Simple Paybuck (yrs)	3.6	1.4	4.0	42	
		133	<b>88</b>	45	-53	5	45	<i>i</i>	كمسة	SIR	SZ	5.1	13	3	3
option of	60 66. 200		Coenst. Cost			98	King.	e de la composición del composición de la compos	fret	Const. Cost (5)	巨		(Service)	(3)	2440
	Victoria de la companya della companya della companya de la companya de la companya della compan		Total Ammuni Savings (\$\foralle{x}\to r\)	(386)	(EE)	回	A80			Total Amnua 1 Saving 5 (\$\frac{x}{3}(yr)	<b>P</b>	(33)	Se les	E	B
			Annual Non- Energy Savings	0	0	0	0	•	, ·	Annual Non- Energy Savings (\$yr)	0	0	0	0	0
NO RE	dan.	IO ULATION	Annual Demand Savings (\$/yr)	0	0	0	0	and the	O JLATION	Annual Demand Savings (\$\frac{7}{7}\)	C	0	0	0	0
	O	TABLE 3.10 ECO 1, DUCT INSULATION	Annual Energy Savings (\$/yr)	<b>38</b>	533	177	480	' #]	ECO 1, DUCT INSULATION	Annual Energy Savings (\$/yr)	R	999	209	475	ZI.
		, ECO 1,	Total Energy Savings (MBtu/yr)	K	<b>8</b> %	4	88		ECO 1,	Total Energy Savings (MBtu/yr)	2	Ħ	110	28	
1	·	•	Annual Gas Savings (MBtu/yr)	52	72	3	75			Anmual Gas Savings (MBtn/yr)	*	88	72	19	15
	•		Annual Electric Savings (KWh/yr)	5,620	7,804	301	7,008			Annual Electric Savings (kWhýr)	694	10,385	9,412	7,408	1.982
			Peak Demand Savings (kW)	0	0	0	0			Peak Demand Savings (LiV)	0	0	0	o	- 100 - 100 - 100
			Bldg	270	116 -	105	833	<u> </u>		Bidg	<b>1</b> 5	116	358	043	811
	e koran			2		-	)		<b>3</b>				3		

## S: 3 Aug 92 ( Honory

	PROJE	CT REVIEW	COMMEN	ITS.	Doto 29 S	uly 1992 Page of
10:	SEA	BROOK_		FROM: (See	RO taok	MELDT
Projec	ti Energy	Soviner Opp	orlanty S		Year:	Line Item No.:
Locat		NCPheison,	GA.	,	FY-92	-
	of Action:	Proliminary Final		Paving & C	Grading tectural	Mechanical Electrical
bare	12)			S	tructural	Sanitary
Item No.	Drawing No. or Par. No.		COMMEN			REVIEW ACTION*
1	Appandix 8, Interim Subnition	1+on # 13- 6	rross Have	Not Bee	in Corridal	-X
	Pg 2.0 F 8	Voltages!	: WILL	\$13 C	CORREC	RED.
				0 . 0	015	and
	<b>&gt;</b>	THUBA	iches of	SSS BE	3 USDO	PESSED
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AFZK-EH Form 129, 1 Apr 82

\* A-E to fill in the review action on the reproducible copy and return to Post.

PROJECT COMME	NTS Date: 3 Aug 1992	Page 1 of 1						
		——————————————————————————————————————						
Project: Ener	gy Savings Opp. Survey To: EMC Engineers							
FY: 1992	McPherson, GA Thru: PM-MP/Lindemo	eier						
LI: 2006000	Thru: EN-D/Lupton							
CN:	Thru: EN-DF/Hughes							
UN .	From: EN-DF/William	ns						
10% Subm	Foundation Report Preliminary Submittal Annotated Comments  10% Submittal X Pre-Final Submittal Customer Comments  Concept Submittal Final Submittal Correspondence							
Item Refer	Comment	Action						
	Ft. Gillem Study	STANING						
1. pg C.14.2.1A	This page indicates that the energy savings were from a simulation for Bldg 207. Where is the	A						
	sample catcutation using the equations on page C.14.2.3? How were the factors BLC and G, shown on page C.14.2.3 derived?	j. odje						
2. pg ES-2	Add measuremnent only to ECO 4 of the separately bound Executive Summary and Volume I.	A						
3. pg 4-1	Why wasn't ECO-1, Roof Insulation included in any of the projects.	A						
	THERE IS AN ECO							
	tor IBUT ONLY							
	THIS WILL BE WCL.							
	PROJECT.							
	MOSPOC.							
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CHLCULATION WAS USED.

TEXT WILL PE REVISED TO MIRBUE CLARITY.

### APPENDIX B UTILITY RATES AND HISTORICAL USAGE CALCULATIONS

#### **GEORGIA POWER COMPANY**

#### **Full Use Service to Governmental Institutions**

#### SCHEDULE "G-10"

#### AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity, except that service under this tariff is not available to a customer who is served from an underground network system or who applies for service after December 29, 1981 at a service level below 12 kV.

#### APPLICABILITY:

Full use service to large Federal, State, and Municipal agencies and Institutions at a single delivery point through a single meter. This schedule is not applicable to Housing Projects or other Governmental agencies or Institutions whose service requirements are predominantly residential, nor is it available to any customer who has more than one meter per structure.

#### TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

#### MONTHLY RATE - Energy Charge Including Demand Charge:

Base Charge	\$55.00	
All consumption (kWh) not greater than 300 hours times the billing demand: First 50,000 kWh		
Next 150 000 kWh	@	5.824 per kwii
Next 800,000 kWh Over 1,000,000 kWh	@	4.10¢ per kWh
All consumption (kWh) in excess of 300 hours times the billing		
demand	@	1.15¢ per kWh

#### Minimum Monthly Bill:

\$55.00 Base Charge plus \$8.00 per kW of Billing Demand, but not less than \$3,400.00 per month, plus excess kVAR charges and Fuel Cost Recovery as applied to the current month kWh.

#### FUEL COST RECOVERY:

The amount calculated at the above rate will be increased under the provisions of the Company's effective Fuel Cost Recovery Schedule, including any applicable adjustments.

#### DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurement during the current month and the preceding eleven (11) months.

For the billing months of June through September, the Billing Demand shall be the greatest of:

(1) The current actual demand, or,

(2) Ninety-Five percent (95%) of the highest actual demand occurring in any previous applicable summer month (June through September), or,

(3) Sixty percent (60%) of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months of October through May, the Billing Demand shall be the greater of:

(1) Ninety-Five percent (95%) of the highest summer month (June through September), or,

(2) Sixty percent (60%) of the highest winter month (October through May), including the current month.

In no case shall the Billing Demand be less than the greatest of:

(1) The contract minimum, or,

(2) Fifty percent (50%) of the total contract capacity, or,

(3) 3,000 kW for any customer applying for service under this rate subsequent to December 22, 1971, or.

(4) 6,000 kW for any customer applying for service under this rate subsequent to December 29, 1981.

Where there is an indiction of a power factor of less than 95% lagging, the Company may, at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-third of the measured actual kW in the current month. The Company will bill excess kVAR at the rate of \$0.27 per excess kVAR.

#### **TERM OF CONTRACT:**

Not less than one year.

#### **REVENUE ADJUSTMENT:**

The bill calculated at the above rate is subject to change in such an amount as may be determined under the provisions of the Company's Revenue Adjustment Rider, Schedule "RA-1", as approved by the Georgia Public Service Commission or as may be later amended.

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

#### ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Territory:

In the natural gas service areas of the Company as shown on the current Rate Zone Map on file with the Georgia Public Service Commission.

Available:

On Special Contract to any regular natural gas customer on an interruptible basis for commercial purposes whose normal productive uses of gas require a consumption of 1,000 therms or more of gas in any one day in the territory shown above, and who contracts in writing for service under this schedule for substantially all of his fuel requirements that the Company can supply, provided the Company has gas delivery capacity in excess of the then existing requirements of other customers and provided the Company has available to it from its suppliers at the delivery point nearest to the customer an adequate supply of natural gas to meet the customer's requirements. The Company reserves the right to refuse (a) to contract for Firm Use Gas, or (b) to make gas available where the relationship between the average daily consumption and the maximum daily consumption indicates a forced or unusual usage on the maximum day in an attempt to qualify for the minimum daily consumption stated above.

Character of Service:

- 1. All gas delivered under this rate schedule shall be subject to curtailment in whole or in part only after the Company has given at least thirty minutes notice by telephone or otherwise except in force majeure conditions. The Company may curtail customers served under this rate schedule in such order and each customer to such extent as the Company deems necessary for the proper operation of its distribution systems. Upon notice of curtailment by the Company in whole or in part of the supply of gas to the customer, the customer must promptly discontinue use of gas in whole or in part as provided in the curtailment notice.
- 2. Interruptible service may be curtailed at any time after notice as provided in (1) above.
- 3. Firm Use gas as hereinafter defined will not be curtailed except pursuant to the Company's load control provisions filed with and approved by the Georgia Public Service Commission from time to time.

Fifteenth Revised Sheet No. 48
Fourteenth
Canceling Revised Sheet No. 48

#### ATLANTA GAS LIGHT COMPANY

#### LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

#### Rate:

#### Customer Charge:

The monthly customer charge shall be based upon the maximum use occurring in the current month or the prior eleven months as follows:

<u>Maximum monthly use</u>	Monthly Charge
Under 30,000 therms	\$ 300
30,000 to 49,999 therms	375
50,000 to 99,999 therms	475
100,000 to 249,999 therms	800
250,000 to 499,999 therms	1,000
500,000 to 999,999 therms	2,000
1,000,000 to 2,999,999 therms	4,500
3,000,000 to 7,500,000 therms	11,000
Over 7,500,000 therms	18,000

#### Firm Use Charge:

For the quantity of natural gas stated in the contract for service as the Firm Use per day at \$15.60 per therm per year billed at \$1.30 per therm per month.

Commodity Charge:						Monthly Rate <u>Per Therm Net</u>
First	100,000	therms	used	per	month	7.0 cents
Next	200,000	therms	used	per	month	5.7 cents
Over	300,000	therms	used	per	month	4.7 cents

#### Summer Air-Conditioning Rate:

For any customer who qualifies for service under this rate schedule who has installed and regularly operates a gasfired central air conditioning system which meets Company's specifications and which equipment consumes more than 50% of the total gas used during the seven-month period April through October inclusive, all gas used during such period, in excess of 4,000 therms per month, will be billed at 3.5 cents per therm.

#### Firm Use:

Firm Use is the daily rate of taking of gas in therms agreed upon in writing as the maximum rate of delivery which the Company shall be required to make to the customer in any one

#### LIGHT COMPANY ATLANTA GAS

#### LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Firm Use (cont'd) day during any period when the Company's supply of natural gas, in the opinion of the Company, is inadequate to supply the total requirements of all its customers supplied from the delivery point from which the customer is supplied. hourly rate of delivery of Firm Use Gas shall not be greater than 1/18th of the Firm Use per day contracted for. Except in cases of force majeure as defined herein, in the Company fails to deliver for a period of more than 24 continuous hours in any month the amount of the daily firm quantity contracted for, the firm use charge for that month shall be prorated on a daily basis.

Unauthorized Consumption of Gas: In the event the customer fails to comply with any curtailment order of the Company reducing either the customer's hourly or daily use of gas, the Company may elect one of the following options:

- To discontinue completely all deliveries to the custo-(A) mer, including any Firm Gas under contract, during the day customer fails to comply with such curtailment order; or
- To furnish such quantity of overrun gas as the Company, (B) in its judgment determines it can supply, at a surcharge of 50.0 cents per therm in addition to the regular commodity charge for such gas, subject however to discontinuance at any time by the Company at its election.
- To require Customer to pay Company a charge of \$3.00 (C) per therm for all unauthorized gas taken, not supplied by Company pursuant to (B) above, in addition to the regular commodity charge for such gas.

Determination of Therms:

The gas for any billing period, expressed in hundreds of cubic feet shall be multiplied by the average BTU of the gas send-out as determined below and divided by 1,000 in order to determine the number of therms consumed for billing purposes. Such calculation shall be made to the nearest whole therm.

#### ATLANTA GAS LIGHT COMPANY

#### LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

#### Determination of Therms (cont'd)

The average BTU of the gas send-out for billing purposes shall be calculated for each calendar month from the weighted average BTU of natural gas delivered to the Company in the city or area where the customer receives service by the Company's suppliers and from the gas delivered by the Company in such city or area from its standby plants, as determined by appropriate calorimeters operated by the Company or its suppliers.

#### Minimum Monthly Bill For Firm Service:

The minimum monthly bill for firm service shall be the monthly billing.

Minimum Annual Guaranteed Bill For Interruptible Service:
All customers who receive or contract for interruptible service under this rate schedule whose annual bill for volumes of interruptible gas actually consumed is less than \$6,000 shall pay a deficiency payment not to exceed \$1,000. This deficiency payment shall be equal to \$1,000 times a fraction whose numerator is \$6,000 less the actual bill for interruptible service and whose denominator is \$6,000. The customer's minimum annual guaranteed bill for interruptible service shall be based upon the volumes of interruptible gas consumed between August 1 and the following July 31. No minimum annual guaranteed bill obligation for interruptible service shall be effective for contracts which on July 31 have been in effect less than twelve months.

#### Payment:

Bills are due when rendered at the net rate shown above and shall be paid in full at any office of the Company within ten (10) days from the date mailed or otherwise delivered.

#### Terms of Service:

- Company may supply gas from any standby or synthetic source, provided that the gas so supplied shall be reasonably equivalent on a BTU basis to the natural gas normally supplied hereunder.
- 2. Contract for service shall be in writing and specify in writing the daily and hourly rates of consumption and shall be for a minimum period of one year.

#### ATLANTA GAS LIGHT COMPANY

#### LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

#### Terms of Service (cont'd)

- 3. The amount of
  - (a) any sales, gross receipts, franchise, excise, privilege, occupation or other tax or charge whether imposed by statute, ordinance, or franchise contract, that the Company pays to any governmental body, based on, or determined by, the sale of gas hereunder; and
  - (b) any charge paid by the Company to any gas supplier as a result of any sales, excise, gross receipts, or other taxes, license fee, or governmental charges imposed upon such supplier, based on, or determined by, the production, severance, manufacture, transportation or sale of gas hereunder, shall be added to and become a part of the charges to the customer under this rate schedule. Provided however, if any additional payments are imposed upon the customer by reason of this clause, the customer may, by thirty days notice in writing to the Company, cancel his contract and discontinue the use of natural gas service under this rate schedule.
- 4. When gas is delivered at a pressure in excess of 14.73 pounds per square inch absolute, then for the purpose of measurement hereunder, such volumes of gas shall be corrected to a pressure of 14.73 pounds per square inch absolute. It is assumed that the atmospheric pressure is 14.4 pounds per square inch. The measurement of gas volumes shall be adjusted for deviation from Boyle's Law in accordance with generally accepted engineering practice; provided, however, that where gas is delivered through positive displacement meters at a pressure not in excess of 20 pounds per square inch gauge, the gas shall be assumed to obey Boyle's Law.
- 5. Where orifice meters are used, volumes delivered shall be computed in accordance with formulae, tables and methods prescribed in Orifice Metering of Natural Gas, Gas Measurement Committee Report No. 3 of the American Gas Association published April, 1955, reprinted with

#### ATLANTA GAS LIGHT COMPANY

#### LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

#### Terms of Service (cont'd)

5. (cont'd)
revisions in January, 1956. Said volumes shall be
corrected for daily average flowing temperature from
60°F and specific gravity.

Where rotary or turbine type meters are used on installations where customer's annual usage is more than 3,000,000 therms, all volumes measured by such meters shall be corrected to a base temperature of 60°F.

- 6. Gas purchased under this rate shall not be resold by the purchaser thereof in any manner, and the Company will discontinue service upon notice to the Customer, when it is determined that gas is being resold in violation of this provision of the rate schedule, in the event the Customer does not immediately discontinue such resale after such notice.
- 7. In the event either Company or its suppliers or the Customer is unable, wholly or in part, by reason of force majeure to carry out its obligations, other than to make payments for gas received, it is agreed that on giving notice of such force majeure as soon as possible after the occurrence of the cause relied on, the obligations of the Company or the Customer so far as they are affected by such force majeure, shall be suspended during the continuance of any inability so caused but for no longer period, and such cause shall as far as possible be remedied with all reasonable dispatch.
- 8. The term "force majeure" as employed above shall mean acts of God, strikes, lockouts, or other industrial disturbances, acts of the public enemy, war, blockades, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, washouts, arrests, and restraints of governments and people, civil disturbances, explosions, breakage or accident to machinery or lines of pipe, exhaustion or depletion of the Company's stocks of peak shaving fuel, exhaustion or depletion of the Company's supply of underground storage gas, freezing of wells or lines of pipe,

Effective:
With service on and after
February 1, 1992

#### ATLANTA GAS LIGHT COMPANY

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

#### Terms of Service (cont'd)

- (cont'd) 8. partial or complete curtailment of deliveries to Company's suppliers as a result of force majeure under the suppliers' gas purchase contracts, inability to obtain rights-of-way or permits or materials, equipment or supplies, and any other causes, whether of the kind herein enumerated or otherwise, not within the control of the Company or its suppliers or the Customer and which by the exercise of due diligence either the Company or its suppliers or the Customer is unable to prevent or overcome. It is understood and agreed that the settlement of strikes or lockouts shall be entirely within the discretion of the person affected and the above requirement that any force majeure shall be remedied with all reasonable dispatch shall not require the settlement of strikes or lockouts when such course is inadvisable in the discretion of the person affected thereby.
  - 9. A day, as used herein, is defined as a period of 24 consecutive hours, beginning at 8:00 a.m. Standard Time.
  - 10. A month, as used herein, is defined as the period beginning on the first day of the calendar month and ending on the first day of the next succeeding calendar month.

Additional Terms and Provisions:

Service under this schedule is subject to the Terms of Service and Rules and Regulations of the Company, as filed with and approved by the Georgia Public Service Commission from time to time, as well as all future riders and tariff provisions made applicable to service under this schedule by the Georgia Public Service Commission from time to time, including without limitation, the Load Control Provisions, Purchased Gas Adjustment Rider, Franchise Recovery Rider and Direct Bill Take-or-Pay Gas Cost Recovery Rider.

Effective:
With service on and after
February 1, 1992

#### **UNIT ENERGY COSTS**

EMC PROJECT:

#3105.000

FILE: PRPARED BY: NRGCOST.WK3 DENNIS JONES

CHECKED BY:

#### NATURAL GAS - MONTHLY CHARGES

MONTHLY CUSTOMER CHARGE

\$250

FIRM USE CHARGE \$1.300 PER THERM

FORT McPHERSON FORT GILLEM

\$7,800 \$10,400

6,000 THERMS 8,000 THERMS

CONSUMPTION:

MONTHLY METER READING (MCF) X 10.29 THERMS/MCF = THERMS

COST OF FIRST 100,000 THERMS COST OF NEXT 200,000 THERMS

\$0.070 PER THERM \$0.057 PER THERM

\$0.047 PER THERM

COST OF OVER 300,000 THERMS

GAS ADJUSTMENT (FIRM):

\$0.397 PER THERM

91/92 AVERAGE

(SEE GAS RATE ANALYSIS)

INCREMENTAL GAS COST SAVINGS:

THE GAS ADJUSTMENT DOMINATES GAS COSTS

\$0.397 PER THERM

MOST GAS USAGE IS IN THE 100,000 THERM BLOCK RESULTING INCREMENTAL GAS COST IS

\$0.070 PER THERM \$0.467 PER THERM \$4.670 PER MBTU

RESULTING INCREMENTAL GAS ENERGY COST IS

ELECTRICITY - MONTHLY CHARGES

BASE CHARGE

\$55

CONSUMPTION:

KWH LESS THAN 300 X BILLING DEMAND

COST OF FIRST 50,000 KWH COST OF NEXT 150,000 KWH \$0.0600 PER KWH \$0.0582 PER KWH

COST OF NEXT 800 000 KWH

\$0 0442 PER KWH

COST OF OVER 1,000 000 KWH

\$0.0410 PER KWH

KWH MORE THAN 300 X BILLING DEMAND

\$0.0115 PER KWH

BILLING DEMAND IS GREATEST OF:

(1) CURRENT MONTHLY ACTUAL DEMAND

(2) 95% OF HIGHEST DEMAND IN PREVIOUS JUNE THRU SEPTEMBER (3) 60% OF HIGHEST DEMAND IN PREVIOUS OCTOBER THRU MAY

POWER FACTOR CHARGE: POWER FACTOR < 959

\$0.27 PER KVAR

FUEL COST RECOVERY:

\$0.0140 PER KWH

MINIMUM MONTHLY BILL:

\$55 BASE CHARGE + \$8.00 PER KW OF BILLING DEMAND BUT NOT LESS THAN \$3,400

PLUS POWER FACTOR CHARGE AND FUEL COST RECOVERY

INCREMENTAL ELECTRIC COST SAVINGS: (\$0.0410-\$0.0115)\*300=\$8.85

\$0.0115+\$0.0140=\$0.0255

NO SAVINGS FOR REDUCTION IN MONTHLY DEMAND \$8.85/KW SAVINGS FOR REDUCTION IN ANNUAL PEAK DEMAND \$0.0255/KWH SAVINGS FOR REDUCTION IN USAGE

WATER-MONTHLY CHARGES

CHARGE:

COST OF FIRST 3 CCF (BASE CHARGE) \$3.35 COST OF NEXT 067 CCF AT \$1.70 PER CCF COST OF NEXT 600 CCF AT \$1.04 PER CCF

COST OF OVER 670 CCF AT \$0.72 PER CCF

SEWAGE-MONTHLY CHARGES

BASE CHARGE:

METER COMSUMPTION AT \$1.95 PER THOUSAND GALLONS

INCREMENTAL SEWAGE SAVINGS

RESULTING INCREMENTAL WATER/SEWAGE COST IS 0.96+1.95=\$2.91 PER THOUSAND GALLONS

748.05 GALLONS/CCF

## HISTORICAL UTILITY USAGE

E M C ENGINEERS, INC. PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT:

ŝ #3105.000

CLIENT OC CLIENT PF	CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK	DACA21- TERRY SE	DACA21-91-C-0097	M ESOS SIL	į.		- <del></del>	DATE: PRIPARED BY:		64/22/92 ENERGY.WK3 DENNIS JONES
							-	CHECKEU BY:	<u>:</u>	
	FORT GILLEM	N.								
DATE	ELECTRIC	ELECTRIC ELECTRIC BILLING		HC HC	00000	<b>AS</b>	WATER	WATER	SEWAGE	SEWAGE
	USAGE (KWH)	DEMAND	DEMAND (KW)	60ST	USAGE	COST (\$)	88 89 18 18 18 18 18 18 18 18 18 18 18 18 18	USAGE (GAL)	& Set Fe	USAGE (GAU
FY90										
<u>SCI</u>	2,035,200	5,213	6,211	112,104	57,815	38,252	7,497	7,520,147	6,106	3,130,400
NOV	1,737,600	4,848		100,655	155,197	83,933	7,922	7,961,496	4,620	
DEC	2,131,200		6,211	114,929	365,521	189,501	6,801	6,797,530	5,443	
AN	2,409,600			122,432	209,241	111,129		6,025,543	2,006	
FEB	1,920,000			107,826	139,875	77,838		6,285,864	5,816	
MAR	2,121,600			114,681	113,897		7,107	7,115,452		
APR	1,920,000	4,877		109,315	72,354			6,338,976		2,821,900
MAY	2,236,800			117,814	14,396			7,410,183		
N N	2,707,200				12,782			6,966,590		
ЛГ	2,755,200			135,462	12,381			6,085,387		
AUG	3,081,600	6,643	6,643		13,431	16,860	7,139	7,148,366		
SEP	2,515,200		6,682	129,332				6,908,242		
TOTAL	27,571,200			1,442,205	1,179,903	693,655	78,351	82,563,776	66,120	33,894,700
FY91										
OCT TOC	2,304,000	5,875	6,348	123,598	54,080	36,171		7,501,445		
NO NO	2,054,400	_		_	124,669			7,198,485		
DEC	2,102,400			<u> </u>	235,094	_				
AN	2,150,400			_	299,628	143,200	10,070	•		
FEB	2,227,200			•		_			6,268	
MAR	1,958,400	5,280		112,076	_			6,626,227		
APR	2,112,000			_						
MAY	2,140,800	6,240	6,348	_			7,917		8,558	
S	2,649,600			_				_		
JJ.	2,793,600			133,320	12,493	_	12,902	•		
AUG	3,014,400			_	13,182		13,896	14,168,067	7,237	3,710,000
SEP	2,544,000	6,768	6,768		15,507		15,209	15,532,510	6,437	3,299,800
TOTAL	28,051,200			1,470,583	1,163,694	644,169	113,177	114,358,892	81,498	41,783,500

91/92 AVG										
<u>8</u>	2,169,600	5,544	6,280	117,851	55,948	37,212	7,488	7,510,796	6,404	3,282,75(
NO NO	1,896,000	4,824	6,280	108,516	139,933	70,601	7,555	7,579,991	4,948	2,536,100
DEC	2,116,800	5,112	6,280	115,411	300,308	153,735	6,789	6,784,814	5,189	2,660,05
NAN NAN	2,280,000	5,247	6,280	119,805	254,435	127,165	5,954	8,109,610	6,455	3,310,70
FEB	2,073,600	5,170	6,280	113,594	173,066	90,603	969'9	6,687,567	6,042	3,097,40
MAR	2,040,000	5,165	6,280	113,379	124,854	69,270	6,872	6,870,840	6,296	3,227,30
APR	2,016,000	5,112	6,280	112,854	54,370	35,996	6,721	6,713,375	6,348	3,254,25
MAY	2,188,800	6,115	6,280	117,590	15,749	17,764	7,654	7,683,222	6,827	3,499,45
N)	2.678.400	6,567	6,567	133,270	13,134	16,593	8,952	9,031,956	6,122	3,138,00
귉	2,774,400	6,730	6,730	134,391	12,437	16,267	9,509	9,610,573	6,831	3,501,75
AUG	3.048.000	6,754	6,754	141,746	13,307	16,631	10,518	10,658,217	6,412	3,287,00
SEP	2,529,600	6,725	6,725	127,989	14,260	17,079	11,059	11,220,376	5,939	3,044,35
TOTAL	8,352,000			404,126	40,004	49,976	31,085	31,489,165	19,181	9,833,100

## ELECTRICITY RATE ANALYSIS EMC PROJECT: #3105.000 DATE: 04/22/92 FILE: NRGCOST.WK3 PRPARED BY: DENNIS JONES CHECKED BY:

FORT GILLEM

		i Oni Git										
		ELECTRIC	CACTUAL	BILLING	<b>ELECTRIC</b>	300 X	FIRST	UP TO	OVER	TOTAL	FUEL	FUEL ADJ
MONTH	DAYS	USAGE	DEMAND	DEMAND	COST	DEMAND	1,000,000	300 X	300 X	KWH	ADJUST	RATE
		(KWH)	(KW)	(KW)	(\$)	(KWH)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$/KWH)
OCT		31 2,304,00	0 5,875	6,348	123,598	1,904,400	47,090	37,080	4,595	88,766	38,928	0.0169
NOV		30 2,054,40	0 4,800	6,348	116,377	1,904,400	47,090	37,080	1,725	85,895	34,711	0.0169
DEC		31 2,102,40	0 5,136	6,348	115,893	1,904,400	47,090	37,080	2,277	86,447	33,733	0.0160
JAN		31 2,150,40	0 5,443	6,348	117,177	1,904,400	47,090	37,080	2,829	86,999	34,503	0.0160
FEB		28 2,227,20	0 5,290	6,348	119,362	1,904,400	47,090	37,080	3,712	87,883	35,735	0.0160
MAR		31 1,958,40	0 5,280	6,348	112,076	1,904,400	47,090	37,080	621	84,791	31,423	0.0160
APR		30 2,112,00	0 5,347	6,348	116,392	1,904,400	47,090	37,080	2,387	86,558	33,887	0.0160
MAY		31 2,140,80	0 6,240	6,348	117,365	1,904,400	47,090	37,080	2,719	86,889	34,349	0.0160
JUN		30 2,649,60	0 6,576	6,576	133,117	1,972,800	47,090	39,885	7,783	94,758	42,513	0.0160
JUL		31 2,793,60	0 6,816	6,816	133,320	2,044,800	47,090	42,837	8,611	98,538	39,043	0.0140
AUG		31 3,014,40	0 6,864	6,864	139,260	2,059,200	47,090	43,427	10,985	101,502	42,129	0.0140
SEP		30 2,544,00	0 6,768	6,768	126,646	2,030,400	47,090	42,246	5,906	95,243	35,555	0.0140
TOTAL		365 28,051,20	0		1,470,582		565,080	465,038	54,151	1,084,270	436,510	

## GAS RATE ANALYSIS — FORT GILLEM EMC PROJECT: #3105.000 DATE: 04/22/92 FILE: NRGCOST.WK3 PRPARED BY: DENNIS JONES CHECKED BY:

	FORT GILL	EM							
	NAT GAS	NAT GAS	FIRM USE	FIRST	NEXT	OVER	GAS	ADJUST	DAILY
MONTH	USAGE	COST	CHARGE	100,000	200,000	300,000	ADJUST	RATE	USAGE
	(THERMS)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$/THERM)	(THERMS)
OCT	55,948	37,212	\$10,400	\$4,084	\$0	\$0	\$22,477	0.4018	1,805
NOV	139,933	70,601	\$10,400	\$7,300	\$2,516	\$0	\$50,135	0.3583	4,664
DEC	300,308	153,735	\$10,400	\$7,300	\$12,600	\$16	\$123,169	0.4101	9,687
JAN	254,435	127,165	\$10,400	\$7,300	\$9,729	\$0	\$99,485	0.3910	8,208
FEB	173,066	90,603	\$10,400	\$7,300	\$4,603	\$0	\$68,049	0.3932	6,181
MAR	124,854	69,270	\$10,400	\$7,300	\$1,566	\$0	\$49,754	0.3985	4,028
APR	54,370	35,996	\$10,400	\$3,969	\$0	\$0	\$21,377	0.3932	1,812
MAY	15,749	17,764	\$10,400	\$1,150	\$0	\$0	\$5,964	0.3787	508
JUN	13,134	16,593	\$10,400	\$959	\$0	\$0	\$4,984	0.3795	438
JUL	12,437	16,267	\$10,400	\$908	\$0	\$0	\$4,709	0.3786	401
AUG	13,307	16,631	\$10,400	\$971	\$0	\$0	\$5,009	0.3764	429
SEP	14,260	17,079	\$10,400	\$1,041	\$0	\$0	\$5,388	0.3778	475
TOTAL	1,171,799	\$668,912	\$124,800	\$49,582	\$31,014	\$16	\$460,500	0.3864	3220

#### EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

#### FORT GILLEM ELECTRICAL DEMAND

#### **JANUARY 1991**

DECIMAL TIME	1/19/91	1/20/91	1/21/91	1/22/91	1/23/91	1/24/91	1/25/91	AVERAGE WEEKDAY	AVERAGE WEEKEND
0.5	2227	2227	2179	2314	2506	2362	2246	2227	
1.0	2227	2227	2179	2304	2486	2323	2237	2227	2321.4
1.5	2246	2227	2179	2304	2496	2342	2246		2305.8
2.0	2208	2218	2170	2323				2236.5	2313.4
2.5	2227	2198			2515	2314	2246	2213	2313.0
3.0	2198	2179	2160	2342	2477	2314	2237	2212.5	230
3.5			2150	2323	2467	2314	2227	2188.5	2296.
	2218	2179	2112	2333	2515	2323	2208	2198.5	2298.
4.0	2179	2179	2112	2323	2467	2294	2208	2179	2280.
4.5	2227	2189	2131	2352	2534	2362	2246	2208	232
5.0	2237	2179	2170	2496	2621	2496	2371	2208	2430.
5.5	2342	2189	2170	2746	2832	2621	2669	2265.5	2607.
6.0	2554	2198	2189	2880	2880	2717	2861	2376	2705.
6.5	2899	2198	2198	3360	3274	3101	3274	2548.5	3041.
7.0	3331	2198	2227	4166	4224	4118	4090	2764.5	376
7.5	3427	2218	2246	4867	4906	4771	4694	2822.5	4296.
8.0	3466	2237	2218	5232	5194	5107	4925	2851.5	4535.
8.5	3494	2246	2227	5347	5251	5174	5050	2870	4609.
9.0	3514	2246	2237	5376	5318	5270	5117	2880	4663.
9.5	3571	2294	2256	5443	5280	5261	5165	2932.5	468
10.0	3581	2304	2227	5434	5290	5270	5155	2942.5	4675.
10.5	3610	2342	2285	5405	5386	5338	5174	2976	4717.
11.0	3648	2390	2314	5405	5376	5299	5155	3019	4709.
11.5	3638	2381	2314	5395	5338	5290	5146	3009.5	4696.
12.0	3619	2381	2352	5290	5290	5280	5088	3000	466
12.5	3466	2400	2352	5299	5290	5299	5059	2933	4659.
13.0	3398	2400	2323	5328	5251	5280	5050	2899	4646.
13.5	3216	2390	2333	5366	5251	5270	5030	2803	465
14.0	3197	2371	2304	5299	5222	5203	4982	2784	460
14.5	3053	2352	2294	5213	5155	5222	4867	2702.5	4550.
15.0	2880	2371	2266	5184	5098	5270	4781	2625.5	4519.
15.5	2851	2333	2285	5165	5050	5155	4790	2592	448
16.0	2630	2314	2227	4846	4570	4579	4214	2472	4087.
16.5	2534	2352	2227	4186	4880	3994	3494	2443	3756.
17.0	2467	2314	2218	3792	3715	3552	3053	2390.5	326
17.5	2429	2266	2208	3466	3370	3139	2755	2347.5	2987.
18.0	2429	2275	2256	3187	3034	3034	2707	2352	2843.
18.5	2419	2304	2352	2976	2890	2957	2698	2361.5	2774.
19.0	2390	2304	2342	2861	2794	2918	2650	2347	271
19.5	2371	2304	2352	2813	2746	2784	2611	2337.5	2661.
20.0	2362	2294	2342	2774	2630	2746	2611	2328	2620.
- 20.5	2333	2314	2342	2707	2602	2755	2554	2323.5	259
21.0	2333	2285	2342	2688	2554	2736	2448	-	
21.5	2275	2246	2342	2621				2309	2553.
22.0	2275				2486	2630	2333	2260.5	2486.
22.5	2256	2218	2285	2573	2458	2554	2275	2237	242
		2227	2352	2592	2438	2544	2275	2241.5	2440.
23.0	2256	2198	2342	2563	2400	2496	2246	2227	2409.4
23.5	2227	2208	2333	2525	2352	2458	2256	2217.5	2384.8
24.0	2218	2170	2294	2515	2352	2448	2246	2194	2371

#### EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

co:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

#### FORT GILLEM ELECTRICAL DEMAND

								AVERAGE	AVERAGE
ECIMAL TIME	8/3/91	8/4/91	8/5/91	8/6/91	8/7/91	8/8/91	8/9/91	WEEKDAY	WEEKEND
0.5	2947	2957	2928	3158	3254	3187	3283	1437.273	295
1.0	2899	2928	2870	3139	3187	3149	3216	2091.4	2913.
1.5	2861	2880	2832	3101	3139	3110	3178	2336.55	2870.
2.0	2813	2832	2784	3034	3101	3062	3110	2472.88	2822.
2.5	2755	2813	2813	3053	3139	3082	3101	2567	278
3.0	2736	2822	2755	3014	3091	3082	3053	3066.833	277
3.5	2765	2765	2746	2976	3043	3005	3043	3033.6	
4.0	2736	2755	2707	2976	2986	2995	3014	3004.167	2745
4.5	2726	2698	2736	2986	2966	3005	3053	2983.7	271
5.0	2698	2698	2822	3072	3062	3110	3158	2988.133	269
5.5	2669	2707	2947	3254	3206	3293	3302	3015.267	268
6.0	2650	2650	2966	3283	3283	3370	3389	3058.467	265
6.5	2688	2717	3350	3619	3658	3782	3754	3170.133	2702
7.0	2726	2678	4253	4483	4502	4646	4493	3426.767	270
7.5	2669	2669	5011	5174	5126	5222	5165	3791.833	266
	2698	2678	5539	5626	5558	5731	5568	5604.4	
8.0	2832	2765	5798	5942	5808	6019	5933	5900	
8.5		2832	5971	6115	5981	6144	6038	6049.8	
9.0	3005		6106	6163	6144	6298	6230	6188.2	
9.5	3101	2918		6307	6202	6403	6307	6270.6	
10.0	3197	3043	6134	6403	6298	6499	6422		
10.5	3226	3139	6269	6422	6336	6509	6509		
11.0	3312	3216	6307		6480	6566	6442		
11.5	3350	3264	6442	6566 6634	6538	6576	6374	6520.4	
12.0	3350	3350	6480	6672	6643	6614	6394		
12.5	3446	3370	6480	6768	6653	6672	6480		
13.0	3485	3427	6528			6730	6470		
13.5	3504	3475	6634	6787	6701	6730	6490		
14.0	3533	3504	6643	6787	6653	6768	6528		
14.5	3542	3590	6710	6835	6672			6716.2	
15.0	3629	3562	6730	6864	6710	6730	6547		
15.5	3552	3542	6691	6749	6720	6634	6499		
16.0	3562	3504	6086	6115	6192	6067	5693		
16.5	3581	3494	5290	5261	5395	5242	4963		
17.0	3514	3485	4790	4858	4867	4838	4541		
17.5	3494	3418	4502	4560	4637	4560	4291	4510	
18.0	2446	3398	4205	4406	4397	4397	4186		
18.5	3370	3360	4051	4234	4128	4195	3994		
19.0	3264	3302	3888	4022	3965	4090	3734		
19.5	3226	3245	3830	3926	3878		3581	3837.8	
20.0	3149	3178	3706	3888	3782		3379		
20.5	3178	3139	3686	3830	3706	3782	3293		
21.0	3158	3139	3677	3725	3696	3686	3283		
21.5	3178	3158	3571	3590	3571	3610	3178		
22.0	3149	3120	3485	3485	3533	3533	3130	3433.2	
22.5	3062	3043	3379	3379	3456	3485	3082		3052
23.0	3034	3062	3341	3389	3312	3408	3034		
	3005	2976	3283	3322	3283		3024		
23.5 24.0		2966	3197	3274	3235		2947		

#### EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

#### FORT GILLEM ELECTRICAL DEMAND

#### **JANUARY 1992**

ADDILLE THE	o a veri i i i i i i i i i i i i i i i i i i	-11.2.2	7000 1 2 2 3 2 3 2 3 3 3 3			***************************************	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	AVERAGE	AVERAGE
DECIMAL TIME	1/11/92	1/12/92	1/13/92	1/14/92	1/15/92	1/16/92	1/17/92	WEEKDAY	WEEKEND
0.5	2266	2160	2045	2112	2438	2429	2477	2300.2	2213
1.0	2237	2179	2006	2122	2381	2419	2477	2281	2208
1.5	2237	2141	2016	2112	2371	2410	2458	2273.4	2189
2.0	2266	2179	2026	2093	2362	2429	2486	2279.2	2222.5
2.5	2275	2189	2016	2122	2352	2448	2496	2286.8	2232
3.0	2237	2189	2035	2093	2381	2458	2506	2294.6	2213
3.5	2266	2189	1997	2093	2400	2419	2506	2283	2227.5
4.0	2294	2170	1997	2074	2410	2486	2582	2309.8	2232
4.5	2275	2170	2006	2102	2410	2496	2544	2311.6	2222.5
5.0	2275	2170	2160	2237	2554	2621	2650	2444.4	2222.5
5.5	2323	2179	2285	2429	2746	2669	2678	2561.4	2251
6.0	2563	2179	2467	2582	2842	2746	2803	2688	2371
6.5	2880	2246	2938	2995	3226	3197	3254	3122	2563
7.0	3014	2314	3686	3869	4003	4090	4186	3966.8	2664
7.5	3062	2438	4358	4406	4608	4810	4858	4608	2750
8.0	3043	2419	4723	4781	4982	5184	5136	4961.2	2731
8.5	3110	2410	4762	4867	5078	5328	5242	5055.4	2760
9.0	3168	2448	4858	4973	5194	5328	5261	5122.8	2808
9.5	3206	2496	4886	5078	5251	5395	5290	5180	2851
10.0	3264	2506	4896	5088	5261	5405	5280	5186	2885
10.5	3254	2506	4848	5078	5213	5386	5222	5149.4	2880
11.0	3216	2515	4810	5098	5213	5395	5242	5151.6	2865.5
11.5	3197	2515	4771	5088	5184	5434	5232	5141.8	2856
12.0	3130	2486	4810	5098	5155	5386	5174	5124.6	2808
12.5	2755	2477	4800	5107	5155	5328	5126	5103.2	2616
13.0	2707	2448	4762	5098	5088	5309	5078	5067	2577.5
13.5	2669	2448	4762	5050	5059	5318	5040	5045.8	2558.5
14.0	2602	2429	4752	5069	5040	5290	5021	5034.4	2515.5
14.5	2525	2400	4733	5059	5040	5280	4992	5020.8	2462.5
15.0	2467	2362	4666	5050	4973	5155	4915	4951.8	2414.5
15.5	2448	2333	4598	4954	4906	5107	4838	4880.6	2390.5
16.0	2381	2304	4051	4483	4349	4541	4022	4289.2	2342.5
16.5	2362	2256	3418	3888	3754	3974	3350	3676.8	2309
17.0	2285	2189	3034	3466	3389	3562	2995	3289.2	2237
17.5	2246	2150	2822	3216	3168	3350	2803	3071.8	2198
18.0	2246	2179	2678	3043	2957	3091	2698	2893.4	2212.5
18.5	2275	2218	2582	2928	2918	2966	2717	2822.2	2246.5
19.0	2256	2189	2534	2832	2861	2918	2611	2751.2	2222.5
19.5	2237	2141	2477	2842	2803	2870	2544	2707.2	2189
20.0	2237	2131	2362	2774	2736	2851	2496	2643.8	2184
20.5	2227	2131	2304	2736	2746	2822	2486	2618.8	2179
21.0	2218	2122	2275	2688	2678	2707	2477	2565	2170
21.5	2179	2093	2227	2659	2611	2640	2410	2509.4	2136
22.0	2170	2064	2179	2515	2621	2602	2400	2463.4	2117
22.5	2160	2054	2141	2467	2621	2592	2381	2440.4	2107
23.0	2179	2056	2150	2458	2573	2534	2381	2419.2	2117.5
23.5	2170	2035	2122	2467	2506	2496	2362	2390.6	2102.5
24.0	2170	2035	2083	2448	2448	2467	2323	2353.8	
27.0	2170	2000	2000	2440	2440	240/	2020	2000.0	2102.5

#### APPENDIX C

### ENERGY CONSERVATION OPPORTUNITY BACKUP CALCULATIONS

<u>Section</u>	ECO Description
C-1.1	WALL INSULATION ROOF INSULATION
C-1.2	PIPE AND DUCT INSULATION
C-1.3	INSULATED GLASS
C-2	WEATHERSTRIPPING AND CAULKING
C-3 C-4	MEASURE HOT WATER TEMPERATURES
	ELECTRIC MOTORS
C-5 C-6	ADD FCONOMIZERS
C-6 C-7	CONTROL HOT WATER CIRCULATION PUMPS
C-7 C-8	INISTALL LOW-FLOW SHOWER AND FAUCET FIXTURES
C-9	HEAT RECLAIM FOR HOT REFRIGERANT GAS
C-10	PREVENT AIR STRATIFICATION
C-10 C-11	REPLACE STREET LIGHTS
C-11 C-12	REVISE OR REPAIR HVAC CONTROLS
C-12 C-13	THERMAL STORAGE
C-14.1	LOADING DOCK SEALS
C-14.2	RADIANT HEATERS
C-15.1	BUILDING 200 LIGHTING CONTROLS
C-15.2	SEPARATE SWITCHES TO CONTROL LIGHTING
C-16	INVESTIGATE POST DEMAND USAGE
C-17	EVALUATE BOILER OPERATION
C-18	EXIT SIGN RETROFIT
C-19	LIGHTING UPGRADES
C-20	COMPUTER SIMULATION SUMMARIES

### APPENDIX C-1.1 WALL INSULATION

#### WALL INSULATION SAMPLE CALCULATION, ECO #1 BUILDING 505 (GILLEM)

#### Given:

- from bldg plans  $= 31,400 \text{ ft}^2$ Gross Wall Area Window Area = 8,068 tt<sup>2</sup>
Existing Wall U-value = 0.184 Btuh / hr °F ft<sup>2</sup>
Improved Wall U-value = 0.065 Btuh / hr °F ft<sup>2</sup>
= 0.021 MBtu / UA - from bldg plans / survey notes - from survey notes - from survey notes - from Bldg 100 simulation Electric Savings Factor = 0.81 kWh / UA

Demand Savings Factor = 0.0 kW - from Bldg 100 simulation - from Bldg 100 simulation - from utility rate analysis = \$4.67 / MBtu Gas Cost - from utility rate analysis = \$0.0255 / kWhElectric Cost - from utility rate analysis = \$8.85 / kWDemand Cost

#### Net Wall Area:

 $31,400 \text{ ft}^2 - 8,068 \text{ ft}^2 = 23,332 \text{ ft}^2$ 

#### Existing Wall UA:

 $(23,332 \text{ ft}^2)^*(0.184 \text{ Btuh / hr °F ft}^2) = 4,293 \text{ Btuh / hr °F}$ 

#### Improved Wall UA:

 $(23,332 \text{ ft}^2)*(0.065 \text{ Btuh / hr °F ft}^2) = 1,517 \text{ Btuh / hr °F}$ 

#### Delta UA:

4,293 - 1,517 = 2,777 Btuh / hr °F

#### Peak Demand Savings:

(2,777 UA)\*(0.0 kW / UA) = 0.0 kW

#### **Annual Energy Savings:**

- Gas:  $(2,777 \text{ UA})^*(0.021 \text{ MBtu / UA}) = 58.3 \text{ MBtu}$ - Electric:  $(2,777 \text{ UA})^*(0.81 \text{ kWh / UA}) = 2,249.4 \text{ kWh}$ 

#### **Annual Cost Savings:**

 $(58.3 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (2,249.4 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + .95 * 8) = \$330 / \text{yr}$ 

#### **Estimated Construction Cost:**

 $4.04\ /\ ft^2$  of wall - from engineer's cost estimate

 $($4.04 / ft^2)*(23,332 ft^2) = $94,261$ 

\$94,261 + (\$94,261 \* .055 SIOH) + (\$94,261 \* .06 DESIGN) = \$105,101

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 1 - Wall Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097

PREPARED BY: R. GERRANS

CHECKED BY:

EMC PROJECT: #3105.000

DATE: 23 APRIL 1992 FILE: ECO-1W.WK3

CLIENT PROJECT ENG: TERRY SEABROOK

 ENERGY
 DISCOUNT

 COST
 FACTOR

 Gas Savings
 \$4.67 / MBtu
 23.77 UPWG

 Electric Savings
 \$0.0255 / kWh
 15.61 UPWE

 Demand Savings
 \$8.85 / kW
 14.53 UPW

Economic Life: 25 yrs

FEAK         ANNUAL         ANNUAL         TOTAL         ANNUAL         FORMAND ELECTRIC GAS         ENERGY ENERGY ENERGY ENERGY SAVINGS								ANNUAL		The state of the s		
DEMAND         ELECTRIC         GAS         ENERGY         ENERGY         DEMAND         ENERGY         ANINGS         SAVINGS		PEAK			TOTAL	ANNOAL	ANNOAL	-NON	TOTAL			į.
SAVINGS         SAVINGS <t< th=""><th>BLDG #</th><th>DEMAND</th><th>ELECTRIC</th><th>GAS</th><th>ENERGY</th><th>ENERGY</th><th>DEMAND</th><th>ENERGY</th><th>ANNOAL</th><th>CONSI</th><th>HIS.</th><th>SIMPLE</th></t<>	BLDG #	DEMAND	ELECTRIC	GAS	ENERGY	ENERGY	DEMAND	ENERGY	ANNOAL	CONSI	HIS.	SIMPLE
(kW)         (kWh/yr)         (MBtu/yr)         (MBtu/yr)         (%yr)         (\$/yr)         (\$		SAVINGS		SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST		<b>PAYBACK</b>
19         18,111         217         \$1,477         \$1,921         \$0           0         2,920         76         86         \$430         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66		(kW)	(kWh/yr)	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$)		(yrs)
0         2,920         76         86         \$430         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66 <td>101</td> <td>19</td> <td><b> </b></td> <td>217</td> <td></td> <td></td> <td>_</td> <td><b>\$</b></td> <td>\$3,398</td> <td>\$135,814</td> <td>0.4</td> <td>40</td>	101	19	<b> </b>	217			_	<b>\$</b>	\$3,398	\$135,814	0.4	40
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330         \$0         \$330	207	0		9/	86				\$430	\$135,899	0.1	316
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330         \$0         \$330         \$0         \$330         \$0	505	0	2,249	58	99				\$330	\$105,101	0.1	319
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330	506	0		58	99				\$330		0.1	319
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330         \$0         \$330         \$0         \$330         \$0	507	0	2,249	58	99				\$330	\$105,101	0.1	319
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330	508	0	2,249	28	99				\$330		0.1	319
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330	509	0		58	99				\$330		0.1	319
0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330	510	0	2,249	58	99				\$330	\$105,101	0.1	319
0         2,249         58         66         \$330         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330           0         2,249         58         66         \$330         \$0         \$0         \$330	511	0	2,249	58	99				\$330	\$105,101	0.1	319
0         2,249         58         66         \$330         \$0         \$0           0         2,249         58         66         \$330         \$0         \$0	512	0	2,249	58	99				\$330	\$105,101	0.1	319
0 2.249 58 66 \$330 \$0 \$0	513	0		58	99				\$330	\$105,101	0.1	319
	514	0	2,249						\$330	\$105,101	0.1	319

## E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 1 - Wall Insulation

CLIENT CONTRACT NO. DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

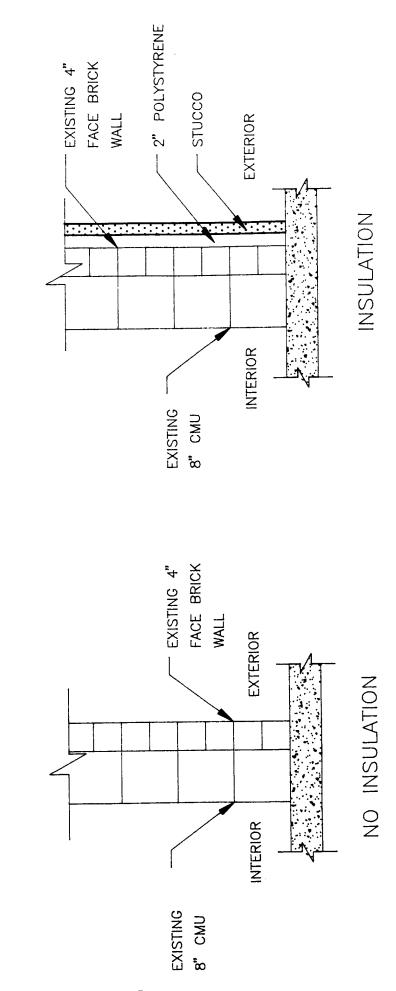
EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-1W.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	CONST	COST	9	\$3.43 \$121,806	\$121,883	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261	\$94,261
ENO	CONST	COST	(\$/#2)	\$3.43	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04	\$4.04
ANNUAL	GAS	SAVINGS	(MBtu/yr)	217	92	58	28	58	58	58	28	28	58	58	58
ANNUAL	ELECTRIC	SAVINGS	(kWh/yr)	18,111	2,920	2,249	2,249	2,249	2,249	2,249	2,249	2,249	2,249	2,249	2,249
PEAK	DEMAND	SAVINGS	(kW/yr)	18.7	0	0	0	0	0	0	0	0	0	0	0
	GAS	SAVINGS	(MBtu/UA)	0.036	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
	ELECTRIC	SAVINGS	(KWh/UA)	3.0	0.81	0.81	18.0	0.81	0.81	0.81	0.81	0.81	0.81	18.0	0.81
		SAVINGS	(KW/UA)	0.0031	0	0	0	0	0	0	0	0	0	0	0
		DELTA	۲	6,037	3,590	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777
	IMPRVD	WALL	NΑ	2,841	1,961	1,517	•	1,517	1,517	1,517	1,517	1,517	1,517	1,517	1,517
	IMPRVD	WALL	U-VALUE	0.08	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
	EXIST	WALL	NA	8,878	5,551	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293
	EXIST	WALL	U-VALUE	0.25	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184
NET NET	WALL	AREA	(H2)	35,512	30,169	23,332	23,332	23,332	23,332	23,332	23,332	23,332	23,332	23,332	23,332
GROSS	WALL	AREA	(ft²)			31,400	31,400	31,400	31,400	31,400	31,400	31,400	31,400	31,400	31,400
		AREA	(ft²)			890'8	8,068	890'8	890'8	8,068	890'8	890'8	8,068	890'8	8,068
_	BLDG #	_		101	207	505	206	507	208	509	510	511	512	513	514

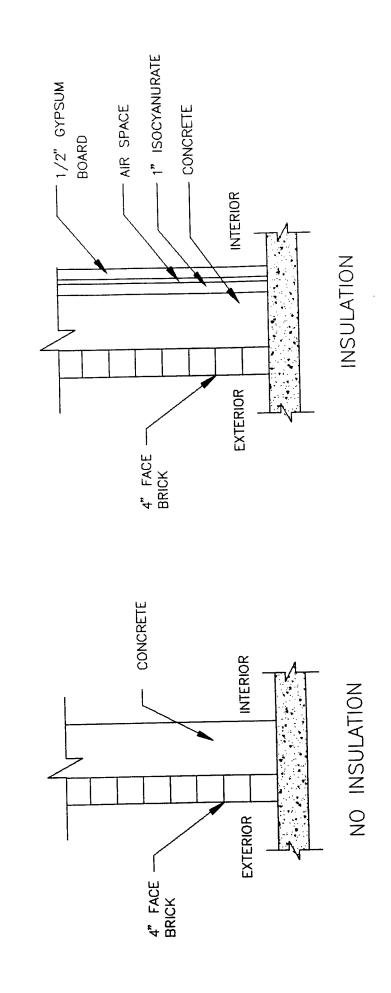
SOST FISH TANK TOOLS	ANAL	<u>0</u>			=	VITATION R	INVITATION NO./CONTRACT NO.	ġ		EFFECTIVE PRICING	RICING	DATE PREPARED	
						DACA 21-	DACA 21-91-C-0097			DATE APR 92	22	Ā	
DESCRIPTION OF F. Gillem ESOS Study	Study					X CODE A	CODEB	CODEC		DRAWING NO.	o.	SH OF	
-						OTHER				SAMO GOTANATO	CVVC	CHECKEDRY	
										COLUMN TO THE PARTY OF THE PART			١
	Quantity	ıtity		LABOR	-		EQUIPMENT	MENT	MATERIAL	Z.	<u>4</u>	SHITING	י ב
ECC 1 — Wall Insulation, exterior	So. Q	Ę	ÌΨ	Total			Unit		ž,			5 5	lota
TARK DESCRIPTION	\$155 5	Meas	Ę	Hrs	Price	Cost	Price	Š	Price	Sost		Ĭ.	Ř
SOLVETYBENE EXTRIDED 2	-		0.011	0.011	\$18.53	\$0.20			<b>\$</b> 0.88	<b>\$</b> 0.88	\$1.08		
CTION SOATS 1-THICK MESH	-		0.081	0.081	\$18.53	\$1.50			\$0.23	\$0.23	\$1.72		
SIUCCO, SCONIS, I TRICK MEST													
			-										
	-												
								-					
	-												
											-		
	-	_											
											\$2.81		1
SUBTOTAL	1										\$0.42	01	
OVERHEAD, BOND	13%										\$0.28	8	
PROFIT	\$										\$3.51		
COST SUB-TOTAL											\$0.53		
CONTINGENCY	15%	.0						-			2		
SUBTOTAL		<u> </u>											
S&A	-	-						-					
											<b>2</b> .04		
ATOL													

COST ESTIMATE ANALYSIS	ANAL	SIS				NVITATION N	INVITATION NO./CONTRACT NO.	o		EFFECTIVE PRICING	PRICING	DATE PREPARED	<u>a</u>
						DACA 21-	DACA 21-91-C-0097			DATE APR 92	82	15-Apr-92	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	tudy					X CODE A	CODEB	CODEC		DRAWING NO.	o.	SHT OF	
LOCATION Ft. McPherson & Ft Gillem									•	ESTIMATOR FIMG	FIMG	CHECKED BY	
	Quantity	<b>≢</b>	<i>i</i>	LABOR	Œ		EQUIPMENT	ENT	MATERIAL	IM	TOTAL	SHIPPING	<u>១</u>
ECO 1 - Interior Wall Insulation	₽. Q.	Ę	¥	Total	Cait		Cnit		Ç.			ž.	Total
TASK DESCRIPTION	SELECTION OF THE PERSON OF THE	Meas	Ç	Hrs	Price	Cost	Price	S	Price	Cost		₹	₹
ISOCYANURATE, FOL FACED, 1"	-	R	!	0.012	\$18.53	\$0.22			\$0.60	\$0.60	\$0.82		
7 STILD GA V 1-1/2 WIDE	-		0.018	0.018	\$18.53	\$0.33			\$0.14	\$0.14	\$0.47		
DRWWALL 5/8" TAPED & FINISHED	-		0.020	0.020	\$18.53	\$0.37			\$0.31	\$0.31			
WALL SWITCH, LIGHTS	0.01	য়	0.240	0.002	\$21.17	\$0.05			\$4.08	\$0.04	\$0.09		
RECEPTACLE DUPLEX 120 VOLT	0.01	SSF	0.240	0.002	\$21.17	\$0.05			\$2.10	\$0.02	\$0.07		
PAINT 2 COATS, SPRAY	-		9000	900.0	\$17.27	\$0.10			\$0.14	\$0.14	\$0.25		
		j											
		_											
SUBTOTAL											\$2.39		
OVERHEAD BOND	15%										\$0.36		
PROFIT	\$										\$0.24		
COST SUB-TOTAL											\$2.98		
CONTINGENCY	55	_									\$0.45		
SUBTOTAL											<b>53.43</b>		
S&A													
TOTAL											\$3.43		
DA FORM 5418-B. APR 86													

ADD 2" POLYSTYRENE AND STUCCO



ADD 1" ISOCYANURATE AND GYPSUM BOARD



### APPENDIX C-1.2 ROOF INSULATION

PROJECT FISCAL Y	NO. & TI 1992 YEAR	TLE: DACA:	ANALYSIS SUI INVESTMENT PI FT. GILLEM 21-91-C-0097 ETE PORTION I ECONOMIC LI	I MAME	NERGY SAV E: ECO-1 R	INGS OPP OOF INSU	ORTUNI LATION	TY SURVEY
1. INVES A. C B. S C. I D. S E. T	CONSTRICT	ION COST ST ALUE COST ESTMENT (	1A + 1B + 1C	- 1	LD)		\$ \$ -\$	3173436. 174539. 190407. 0. 3538382.
2. ENERG	GY SAVING LYSIS DAT	S (+) / CO E ANNUAL	OST (-) SAVINGS, UNI	r co	ST & DISC	OUNTED S	AVINGS	3
			SAVINGS MBTU/YR(2)					
A. H B. I C. H D. N E. C	ELECT \$ DIST \$ RESID \$ NAT G \$ COAL \$	7.47 .00 .00 4.67	3041. 0. 0. 34889.	\$ \$ \$ \$	22723. 0. 0. 162932. 0.	15.6 21.6 26.5 23.7 16.0	1 6 1 7 6	354701. 0. 0. 3872885. 0.
F. 7	TOTAL		37930.	\$	185654.		\$	4227586.
		VINGS(+)						
A. Al	NNUAL REC	URRING (+	/-) R (TABLE A) ING/COST (3A			14.5	<b>\$</b>	٥.
C. TO	OTAL NON	ENERGY DI	SCOUNTED SAV	ING	S(+)/COST(	-)(3A2+3	Bd4)\$	0.
D. PI	(1) 25% M A IF B IF C IF	MAX NON EN 3D1 IS = 3D1 IS < 3D1B IS	QUALIFICATIO ERGY CALC (2 OR > 3C GO 3C CALC = > 1 GO TO < 1 PROJECT	F5 7 TO SIR IT1	K .33) ITEM 4 = (2F5+3D EM 4	1)/1E)		
4. FIRS	T YEAR DO	LLAR SAVI	NGS 2F3+3A+(	3 <b>B</b> 11				
5. TOTAL	L NET DIS	SCOUNTED S	AVINGS (2F5+	3C)			\$	4227586.
(IF	< 1 PROJ	JECT DOES	IO NOT QUALIFY)					
7. SIMP	LE PAYBAC	CK PERIOD	(ESTIMATED)	ł	SPB=1E/4	1	9.06	

#### ROOF INSULATION SAMPLE CALCULATION, ECO #1 BUILDING 111

#### Given:

Roof Area  $= 2,150 \text{ ft}^2$ - from bldg plans Existing Roof U-value Improved Roof U-value Gas Savings Factor = 0.202 Btuh / hr °F ft<sup>2</sup> - from survey notes  $= 0.042 \text{ Btuh / hr }^{\circ}\text{F ft}^{2}$ - from survey notes - from Bldg 100 simulation = 0.0083 MBtu / UA Electric Savings Factor = 1.8 kWh / UA
Demand Savings Factor = 0.0 kW
Gas Cost = \$4.67 / MBtu - from Bldg 100 simulation - from Bldg 100 simulation Gas Cost = \$4.67 / MBtu - from utility rate analysis - from utility rate analysis Electric Cost = \$0.0255 / kWh- from utility rate analysis Demand Cost = \$8.85 / kW

#### **Existing Roof UA:**

 $(2,150 \text{ ft}^2)*(0.202 \text{ Btuh} / \text{hr } ^{\circ}\text{F } \text{ft}^2) = 434.3 \text{ Btuh} / \text{hr } ^{\circ}\text{F}$ 

#### Improved Roof UA:

 $(2,150 \text{ ft}^2)^*(0.042 \text{ Btuh / hr }^\circ\text{F ft}^2) = 90.3 \text{ Btuh / hr }^\circ\text{F}$ 

#### Delta UA:

$$434.3 - 90.3 = 344.0 \text{ Btuh / hr }^{\circ}\text{F}$$

#### Peak Demand Savings:

 $(344.0 \text{ UA})^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

#### **Annual Energy Savings:**

- Gas: (344.0 UA)\*(0.0083 MBtu / UA) = 2.9 MBtu - Electric: (344.0 UA)\*(1.8 kWh / UA) = 619 kWh

#### **Annual Cost Savings:**

 $(2.9 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (619 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$29 / \text{ yr}$ 

#### **Estimated Construction Cost:**

\$0.68 / ft² of wall - from engineer's cost estimate

$$(\$0.68 / \text{ft}^2)^*(2,150 \text{ ft}^2) = \$1,462$$

\$1,462 + (\$1,462 \* .055 SIOH) + (\$1,462 \* .06 DESIGN) = \$1,630

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 1 - Roof Insulation

PREPARED BY: R. GERRANS

CHECKED BY:

FILE: ECO-1R.WK3

EMC PROJECT: #3105.000

01-Sep-92

DATE:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

 ENERGY
 DISCOUNT

 COST
 FACTOR

 Gas Savings
 \$4.67 / MBtu
 23.77 UPWG

 Electric Savings
 \$0.0255 / kWh
 15.61 UPWE

 Demand Savings
 \$8.85 / kW
 14.53 UPW

Economic Life: 25 yrs

	SIMPLE	PAYBACK (vrs)	19	0	2	2	19	19	19	19	19	19	19	19	19
	SIR		1.2	10	i	7	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	<u></u>
	CONST	COST (\$)	\$311,888	#211 BBB	000,1100	\$311,888	\$311,888	\$311,888	\$311.888	\$311 888	\$311,888	\$311,888	\$311,888	\$419,503	\$185,656 \$3,538,381
	TOTAL	SAVINGS (\$/vr)	\$16.370	010,010	0/0,0/0	\$16,370	\$16,370	\$16,370	\$16.370	\$16.370	\$16.370	\$16,370	\$16,370	\$21,957	
ANNOAL	NON- ENERGY	SAVINGS (\$/vr)	<b>C</b> #	2	2	80	\$0	\$0	C#	0#	<b>9</b> <del>€</del>	0\$	0\$	\$0	\$0
	ANNUAL	SAVINGS	0#	9	O#	\$0	\$0	80	G.	9	9				
	ANNUAL	SAVINGS	#15 370		\$16,370	\$16,370	\$16,370	\$16.370	¢16 370	910,010	#10,370 #46,370				2
	TOTAL	SAVINGS	A SO OF	0,040	3,345	3,345	3,345	3 345	20,00			2,045		4 479	37,928
	ANNUAL	S 3	(MDIU/yr)	3,078	3,078	3,078	3.078	2 078	0,010	0,070	3,078	3,078	3,078	4 109	34,889
	ANNUAL	SAVINGS		CCZ'8/	78,255	78.255	78 255	70,07	70,07	22,87	78,255	78,255	70.055	108 540	
	PEAK	SAVINGS	(KW)	0	0	0	C		0	0	0	0	0		0
	4	* pring		505	206	507	602	900	SOC	510	511	512	513	514	TOTAL

## E M C ENGINEERS, INC.

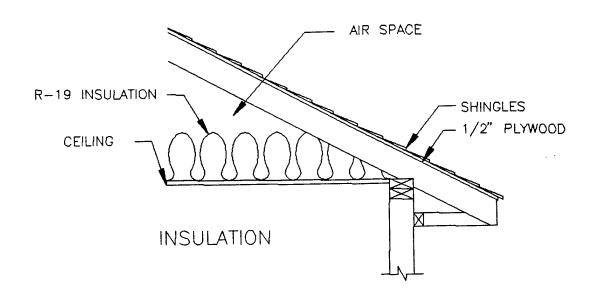
PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM.

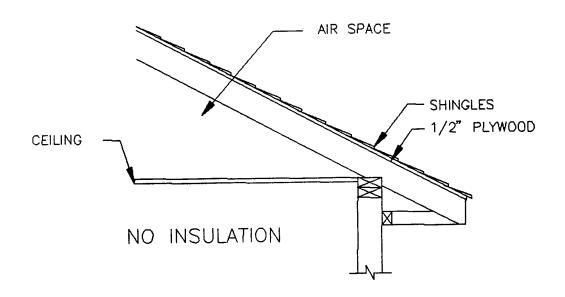
ECO: 1 - Banding.

EMC PROJECT: #3105.000 DATE: 15-APR-92 FILE: ECO-1R.WK3 PREPARED BY: R. GERRANS CHECKED BY:	DEMAND ELECTRIC GAS SAVINGS COST COST COST COST COST COST COST COS
	HAPRVD DELTA  UA UA  7,166 70,171 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170 5,328 52,170
PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM.  ECO: 1 - Roof Insulation  CLIENT CONTRACT NO: DACA21-91-C-0097  CLIENT PROJECT ENG: TERRY SEABROOK	1MPRVD ROOF U-VALUE 0.048 0.048 0.048 0.048 0.048 0.048
& FORT	EXIST ROOF UA 77,337 57,498 57,498 57,498 57,498 57,498 57,498 57,498 57,498
PROJECT: FORT MCPHERSON & FORT GILLEM LOCATION: FORT GILLEM.  ECO: 1 - Roof Insulation  CLIENT CONTRACT NO: DACA21-91-C-0097  CLIENT PROJECT ENG: TERRY SEABROOK	EXIST ROOF U-VALUE 0.518 0.518 0.518 0.518 0.518 0.518 0.518
E FORT A  N: FORT  - ROOI  - ROOI  SOJECTE	AREA (ft²) 111,000 11
PROJECT: FORT McPHER, LOCATION: FORT GILLEM ECO: 1 - Roof Insula CLIENT CONTRACT NO: D, CLIENT PROJECT ENG: TE	BLDG # 207 207 505 505 507 508 508 509 511 511 512 513

Project P. Netherens R. Calen ESOS Shapes   December 2008   Code   Cod	COST ESTIMATE ANALYSIS	NALY	SIS			_	WITATION N	INVITATION NO./CONTRACT NO.	o.		EFFECTIVE PRICING	PRICING	DATE PREPARED	O.
Control Full Methonsois R Colon   Control Full Methon   Colon							DACA 21-	-91 -C-0097			DATE APR	82	Ā	
COCATION P. McPheron & P. Glaver   Colombity   Colom	1.	Ą					X CODE A	CODEB	CODEC		DRAWING	<u>o</u>		
Continue	LOCATION Ft. McPherson & Ft Gillem						OTHER				ESTIMATOR	PMG	CHECKED BY	
FOOT 1 - Red, Washboare									1	MANTER	N N	TOTAL	NIddiris	g
Track DESCRIPTION   Line   Mark   Total bridge   Prince		Quant	4		ABO	- 1		ECCUTA		בו בו	į	 	1111	TO+0
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SECONMUNITE_FOL FACED 9*THICK   1 SF   0.011   0.011   SES	TASK DESCRIPTION		Meas	Ę	Į S	Рпсе	Cost	Luce	Š		2			
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TASK DESCRIPTION	Chits	Meas	Unit	Hrs	Price	Cost	Price	Cost	Price	Sost	!	₹	₹
FIBERGLASS BATTS, R-19	-	SF	0.005	0.005	\$18.53	\$0.08			88.98	\$0.38	\$0.47		
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## APPENDIX C-1.3 PIPE AND DUCT INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY  ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)  INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORT FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 DUCT INSULAT ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY:	GECO2 1.06 3 PUNITY PION KC	25 52 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ \$ -\$	1830. 101. 110. 0. 2041.
2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVI	INGS	
UNIT COST SAVINGS ANNUAL \$ DISCOUNT FUEL \$/MBTU(1) MBTU/YR(2) SAVINGS(3) FACTOR(4)	DISC SAVI	OUNTED NGS (5)
A. ELECT \$ 7.47 16. \$ 117. 15.61 B. DIST \$ .00 0. \$ 0. 21.66 C. RESID \$ .00 0. \$ 0. 26.51 D. NAT G \$ 4.67 38. \$ 177. 23.77 E. COAL \$ .00 0. \$ 0. 16.06		1830. 0. 0. 4218. 0.
F. TOTAL 54. \$ 295.	\$	6048.
3. NON ENERGY SAVINGS(+) / COST(-)		
A. ANNUAL RECURRING (+/-) (1) DISCOUNT FACTOR (TABLE A) 14.53	\$	0.
(1) DISCOUNT FACTOR (TABLE A) (2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd	4)\$	0.
D. PROJECT NON ENERGY QUALIFICATION TEST  (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 19  A IF 3D1 IS = OR > 3C GO TO ITEM 4  B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)  C IF 3D1B IS = > 1 GO TO ITEM 4  D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		
4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE	E))\$	295.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$	6048.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2. (IF < 1 PROJECT DOES NOT QUALIFY)	.96	
	.93	

#### DUCT INSULATION SAMPLE CALCULATION, ECO #1 BUILDING G101

#### Given:

Duct Perimeter Duct Length Existing Ins. Thickness Improved Ins. Thickness Ins. Thermal Cond. Inner Film R-Value Outer Film R-Value Duct TempHeating Duct TempCooling Amb. Temp. Winter Amb. Temp. Summer Delta Enthalpy - Summer Leakage Class w/o insul. Leakage Class w/ added insustatic Pressure Gas Heater Efficiency Gas Cost	= 0.5 in. w.g. = 75% = \$4.67 / MBtu	<ul> <li>from bldg plans / survey notes</li> <li>from bldg plans / survey notes</li> <li>from survey notes</li> <li>assumed</li> <li>from ASHRAE</li> <li>from ASHRAE</li> <li>from ASHRAE</li> <li>assumed</li> <li>assumed</li> <li>assumed</li> <li>assumed</li> <li>assumed</li> <li>ssumed</li> <li>assumed</li> <li>assumed</li> <li>fom ASHRAE</li> </ul>
Electric Cost Demand Cost	= \$0.0255 / kWh = \$8.85 / kW	- from utility rate analysis - from utility rate analysis
Demand Cost	— ψ0.00 / 10 <sup>7</sup>	•

#### **Duct Surface Area:**

$$(80 \text{ in } / 12 \text{ in } / \text{ ft})^*(45 \text{ ft}) = 300 \text{ ft}^2$$

#### Existing Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in } / \text{ ft}^2 \text{ °F}) / (0.5 \text{ in})) = 1.92 \text{ ft}^2 \text{ °F } / \text{ Btuh}$$

#### Existing U-Value:

$$1 / (0.22 + 1.92 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.36 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

#### Improved Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in } / \text{ ft}^2 \text{ °F}) / (2.0 \text{ in})) = 7.69 \text{ ft}^2 \text{ °F } / \text{ Btuh}$$

#### Improved U-Value:

$$1 / (0.22 + 7.69 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.12 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

#### Existing Leakage Rate:

$$(48 \text{ cfm} / 100 \text{ ft}^2)^*(0.5)^{0.65} = 30.6 \text{ cfm} / 100 \text{ ft}^2$$

#### Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

#### Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

#### Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

#### Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{°F})^*(300 \text{ ft}^2)^*(90 - 75 \text{°F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (91.8 \text{ cfm})(90 - 75 °F) = 2020 \text{ Btuh}$$
  
0.75

Total

Summer (electric):

Insulation

$$(0.36 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E}-5 \text{ kW / Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm / cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu / lbm}) * (5.83\text{E-5 kw / Btuh}) = 0.38 \text{ kw}$$

**Total** 

#### Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 75 \text{ °F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (45.9 \text{ cfm})(90 - 75 °F) = 1010 \text{ Btuh}$$
  
0.75

Total

Summer (electric):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E}-5 \text{ kW} / \text{Btuh}) = 0.071 \text{ kW}$$

Leakage

Total

$$(0.071 + 0.19) = 0.26 \text{ kw}$$
  
 $(0.26 \text{ kw}) * (4380 \text{ yrs}) = 1134 \text{ kwh}$ 

Peak Demand Savings: 0 kW

**Annual Energy Savings:** 

**Annual Cost Savings:** 

$$(10.8 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (1494 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$89 / \text{ yr}$$

**Estimated Construction Cost:** 

\$3.05 / ft<sup>2</sup> of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2)^*(300 \text{ ft}^2) = \$915$$

#### PIPE INSULATION SAMPLE CALCULATION, ECO #1 BUILDING G101

#### Given:

Pipe Diameter = 2.0 in - from bldg plans / survey notes
Pipe Length = 100 ft - from bldg plans / survey notes

Existing Ins. Thickness = 1.0 in - from survey notes

Improved Ins. Thickness = 1.5 in - assumed

Ins. Thermal Cond. = 0.26 Btuh in / ft<sup>2</sup> °F - from ASHRAE

Fluid Temperature =  $140 \, ^{\circ}\text{F}$  - assumed Amb. Temperature =  $50 \, ^{\circ}\text{F}$  - assumed Gas Boiler Efficiency = 75% - assumed

Gas Cost = \$4.70 / MBtu - from utility rate analysis

Electric Cost = \$0.0255 / kWh - from utility rate analysis

Demand Cost = \$8.85 / kW - from utility rate analysis

#### **Existing Conductance Coefficient:**

$$ln((2 + 2 * 1.0)/2)/(2 * pi *((0.26 Btuh in / ft² °F)/(12 in / ft))$$
  
= 5.09 ft °F / Btuh

#### **Existing Pipe Surface Temperature:**

assume Rc = 1 ft °F / Btuh

$$(50 \text{ °F}) + (140 - 50 \text{ °F})*(1 \text{ ft °F / Btuh})/(1 + 5.09 \text{ ft °F / Btuh})$$
  
= 64.8 °F

#### **Existing Convection Coefficient:**

hc = 
$$0.18*(64.8 - 40) ^0.33 = 0.52$$
 Btuh / ft<sup>2</sup> °F A = pi \* 2 in \* (1 ft / 12 in) =  $0.52$  ft<sup>2</sup> / ft

 $1 / ((0.52 \text{ Btuh} / \text{ft}^2 \text{ °F})^*(0.52 \text{ ft}^2 / \text{ft})) = 3.68 \text{ ft °F} / \text{Btuh}$ 

#### After 5 iterations:

 $Ts = 74.1 \, ^{\circ}F$ 

 $Rc = 1.86 \text{ ft } ^{\circ}\text{F} / Btuh$ 

#### **Existing Combined Coefficient of Resistance:**

$$5.09 + 1.86 = 6.95$$
 ft °F / Btuh

#### **Existing Annual Energy Loss:**

(140 - 50 °F)\*(100 ft) / ((6.95 ft °F / Btuh)\*(0.75)) = 1,727 Btuh

$$(1,727 \text{ Btuh})^*(4,380 \text{ hrs/yr}) = 7.6 \text{ MBtu/yr}$$

#### Improved Conductance Coefficient:

$$ln((2 + 2 * 1.5)/2)/(2 * pi *((0.26 Btuh in / ft² °F)/(12 in / ft))$$
  
= 6.73 ft °F / Btuh

#### Improved Pipe Surface Temperature:

assume 
$$Rc = 1$$
 ft °F / Btuh

$$(50 \text{ °F}) + (140 - 50 \text{ °F})*(1 \text{ ft °F / Btuh})/(1 + 6.73 \text{ ft °F / Btuh})$$
  
= 61.6 °F

#### **Improved Convection Coefficient:**

hc = 
$$0.18*(61.6 - 40)^0.33 = 0.50$$
 Btuh / ft<sup>2</sup> °F A = pi \* 2 in \* (1 ft / 12 in) =  $0.52$  ft<sup>2</sup> / ft

$$1 / ((0.50 \text{ Btuh} / \text{ft}^2 \text{ °F})^*(0.52 \text{ ft}^2 / \text{ft})) = 3.85 \text{ ft °F} / \text{Btuh}$$

#### After 5 iterations:

$$Ts = 67.7 \, ^{\circ}F$$
  
Rc = 1.65 ft  $^{\circ}F$  / Btuh

#### Improved Combined Coefficient of Resistance:

$$6.73 + 1.65 = 8.38$$
 ft °F / Btuh

#### **Improved Energy Loss:**

$$(140 - 50 \,^{\circ}\text{F})^*(100 \,^{\circ}\text{ft}) / ((8.38 \,^{\circ}\text{F} / \text{Btuh})^*(0.75)) = 1,431 \,^{\circ}\text{Btuh}$$
  
 $(1,431 \,^{\circ}\text{Btuh})^*(4,380 \,^{\circ}\text{hrs/yr}) = 6.3 \,^{\circ}\text{MBtu/yr}$ 

#### Peak Demand Savings: 0 kW

#### Annual Energy Savings:

- Electric: = 0 kW - Gas: (7.6 - 6.3 MBtu) = 1.3 MBtu

#### **Annual Cost Savings:**

$$(1.3 \text{ MBtu})^*(\$4.70 / \text{MBtu}) + (0 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + .95 * 8) = \$6 / \text{yr}$$

#### **Estimated Construction Cost:**

\$4.57 / ft of 1-1/2" insulation on 2" pipe - from engineer's cost estimate

$$(\$4.57 / \text{ft})*(100 \text{ ft}) = \$457$$

1,334 -small construction cost

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

EMC PROJECT: #3105.000 DATE: 15-Jul-92

FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / KW	14.53 UPW
mir John John John		

Economic Life: 25 yrs

	C	6	6
SIMPLE PAYBACK (vrs)	4.5	20.8	
SIR	5.0		3.0
CONST COST (\$)	\$1,020	\$1,020	\$2,040
TOTAL ANNUAL SAVINGS (\$/vr)	\$246	\$49	\$295
ANNUAL NON ENERGY SAVINGS (\$/vr)	\$0	0 <del>\$</del>	80
ANNUAL DEMAND SAVINGS (\$/vr)	0\$	O\$	\$0
ANNUAL ENERGY SAVINGS (\$/vr)	\$246	\$49	\$295
TOTAL ENERGY SAVINGS (MBtu/vr)	45	6	54
ANNUAL GAS SAVINGS (MBtu/vr)	32	9	38
ANNUAL ELECTRIC SAVINGS (kWh/vr)	3,770	826	4,596
PEAK DEMAND SAVINGS (KW)	0	0	0
BLDG #	G735	G101	TOTAL

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000 DATE: 20-Jul-92

FILE: ECO-G1P.WK3 PREPARED BY: CMD CHECKED BY: CEL

LOCATION: FORT GILLEM

ECO: 1 - Pipe Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY DISCC COST FAC \$4.67 / MBtu \$0.0255 / kWh \$8.85 / kWh			
\$4.67 / MBtu \$4.67 / MBtu 1gs \$0.0255 / kWh		ENERGY	DISCOUNT
\$4.67 / MBtu 1gs \$0.0255 / kWh 59.85 / kW		COST	FACTOR
1gs \$0.0255 / kWh	Gas Savings	\$4.67 / MBtu	23.77 UPWG
48 85 / KW	Ciac Carringo	\$0.0255 / kWh	15.61 UPWE
	Domand Savings		14.53 UPW
	7.		

Economic Life: 25 yrs

SIMPLE PAYBACK (yrs)	9.86
SIR	0.4
CONST COST (\$)	\$1,997
TOTAL ANNUAL SAVINGS (\$/yr)	\$34
ANNUAL NON – ENERGY SAVINGS (\$/yr)	<del>\$</del> 0
PEAK ANNUAL ANNUAL TOTAL ANNUAL ANNUAL DEMAND ELECTRIC GAS ENERGY ENERGY DEMAND SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS (\$/yr) (\$/yr) (\$/yr) (\$/yr)	0\$
ANNUAL ENERGY SAVINGS (\$/yr)	\$34
TOTAL ENERGY SAVINGS (MBtu/yr)	7
ANNUAL ANNUAL TOTAL ELECTRIC GAS ENERGY SAVINGS SAVINGS (KWh/vr) (MBtu/yr) (MBtu/yr)	7.30
PEAK ANNUAL ANNUAL SEMAND ELECTRIC GAS AVINGS SAVINGS (KW) (KWh/vr) (MBtu/vr)	0
BLDG # DEMAND ELECTRIC GAS SAVINGS SAVINGS (KW) (KWh/vr) (MBtu/vr)	0
BLDG #	101

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

**ECO: DUCT AND PIPE INSULATION** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

17-Apr-92 EMC PROJECT: #3105.000

FILE: GDUCTPIPE.WK3 DATE:

PREPARED BY: CMD CHECKED BY: CEL

### **HOT WATER PIPES**

REMARKS 1.5 DTW Pipe	
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PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE:

FILE: GDUCTPIPE.WK3

PREPARED BY: CMD CHECKED BY: CEL

### STEAM PIPES

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EQUIRED REMARKS LATION (IN)	2		
IVEY RI	Fiberglass		
SUR THICKNESS (IN)		L	
LENGTH (FT)	200	1	
PIPE DIA. (IN)		N/A	
# DCIB	9404	6738	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 17-Apr-92 DATE:

FILE: GDUCTPIPE.WK3 PREPARED BY: CMD

CHECKED BY: CEL

### **CHILLED WATER PIPES**

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PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

17-Apr-92 EMC PROJECT: #3105.000 DATE:

FILE: GDUCTPIPE.WK3 PREPARED BY: CMD CHECKED BY: CEL

### **DUCTS**

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REQUIRED INS. (IN)			
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PERIMITER DUCT SURVEY LENGTH (FT) THICKNESS (IN)		0	0
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PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

EMC PROJECT: #3105.000

17-Apr-92

FILE: GDUCTPIPE.WK3 PREPARED BY: CMD CHECKED BY: CEL

**ECO: DUCT AND PIPE INSULATION** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

Energy cost:

Gas: \$4.70 / MBtu Electric: 0.0255 /KWH

**EXISTING PIPE INSULATION CONDITION** 

ANNUAL ENERGY COST (\$/vr)	\$35.55	\$121.61
ANNUAL ENERGY LOSS (KWH/vr)	1	-
ANNUAL ENERGY LOSS (MBtu/vr)	7.56	25.88
EXIST TOTAL LOSS (Btuh)	1,295	
TOTAL R (F/Btuh)	6.95	9.25
CONV. R (F/Bluh)	1.86	
COND. R (F/Btuh)	5.09	7.24
SURFACE TEMP. (F/Btuh)	74.05	94.71
Pic (F/Btuh)	1.86	2.02
S P P	20	20
	140	255
k F Btuh in/ T	0.26	0.29
A CONTROL OF THE CONT	-	-
LDG# PIPE INSUE DIA LENGTH THICK (II) (II) (II)	100	200
DIA DIA (ii)	2	-
#5018	G101	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

EMC PROJECT: #3105.000

17-Apr-92

DATE

FILE: GDUCTPIPE.WK3

PREPARED BY: CMD CHECKED BY: CEL

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

Energy cost:

\$4.70 / MBtu Gas:

Electric: 0.0255 /KWH

**NEW PIPE INSULATION CONDITION** 

\$6.06 ANNUAL 29.49 93.25 ENERGY CO61 11.29 6.03 SAVINGS ANNUAL 848 00 ANNUAL ANNUAL ELECTRIC SAVINGS (MMH/yrr) (MBbi/yr) (KWH/yr) 6.28 -19.84 -1068 MPROVED ANNUAL GAS ENERGY LOSS 1,075 3,398 (F/Burk (F/Burh) (F/Burh) (F/Burh) 8.38 12.07 SURFACE COND. CONV. TOTAL 1.65 6.73 Œ 74.94 67.67 TEMP 1.64 2 | PIPE | PIPE | NSUL | | FLUID AMB | | PIPE | PIPE | PIPE | PIPE | PIPE | P 8 8 255 0.29 8 2 #90TH **G101** 

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 10-JUL-92

FILE: ECO-1DG.WK3 PREPARED BY: CMD CHECKED BY: CEL

### EXISTING DUCT INSULATION CONDITION

_						
	DELTA	ENTE		15.6	15.6	15.6
SUMMER	AMB	TEMP	Œ	8	8	8
		TEMP		55	55	55
NTER	AMB	TEMP	Œ	Ц	1	75
<b>₹</b>	DUCT	TEMP TE	E	06	8	8
	OTAL	EAK	cfm)	0.0	51.0	40.8
LEAK	MIE	cfm/	IO FFS)	0.0	30.6	30.6
	STATIC	PRESS	(in. w.a.)	0.5	0.5	0.5
		CLASS		0	84	48
	SZ.	E C	(ju)	0.5	0	0
THERMAL		(Btu in/		0.26	0.26	0.26
				96.0	1.15	1.15
<b>-</b>	Z.			1.92		0.00
Œ	ENER	ž		0.220	0.65 0.220	0.220
Œ	OCTER	E		0.65		0.65
	URFACE	ARC	<b>.</b>	300	167	133
	2 2 2 3 4 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4	PER. LENGTH AREA F	(W)	45	25	10
		PEH.	9	8	8	160
	8LDG	*		G101	G735	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT McPHERSON

	UAL.	ELECTRIC	(KW/yr)	0.096	2626.0	2100.8
	ANN	GAS	(MBtu/yr)	9.4	21.7	17.4
		TOTAL	SES.	0.22	09.0	0.48
OSSES	SUMMER	LEAK	(KW)	1	0.21	
<b>ENERGY L</b>		INSUE		0.22		0.31
		TOTAL	(Btu/h)	2148.2	4953.0	3962.4
	WINTER	LEAK				
		INSNI	(Btu/h)	2148.2	3831.4	3065.1
	BLDG	*		G101	G735	

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM **ECO: 1 -- Duct Insulation** 

EMC PROJECT: #3105.000 DATE: 10-JUL-92

						-	-		_1	L.		اا	
						SUMMER	AMB	TEMP	Œ	8	96	96	
							DUCT		Ξ	55	55	55	
						WINTER	AMB	TEMP	Œ	75	75	75	
						Z X	DUCT	TEMP	Œ	8	8	96	
							TOTAL	LEAK	(ctm)	0.0	25.5	20.4	
						LEAK	RATE	(ctm/	100 ftg	0.0	15.3	15.3	
	ဗ	_			7		STATIC	CLASS PRESS	(in. w.g.) 100 ft2)	0.5	0.5	0.5	
UAIE: 10-30L-92	FILE: ECO-1DG.WK3	PREPARED BY: CMD	BY: CEL		ONDITION		LEAK	CLASS		0	24	24	
DAIE: 10	FILE: ECC	PREPARE	CHECKED BY: CEL		LATION C		SZ	± CK	Œ	2	2	2	
_	_		•		NEW DUCT INSULATION CONDITION	THERMAL	COND.	(Btu in/	h ffe F)	0.26	0.26	0.26	
					VEW D	-	<b>-</b>			0.12	7.69 0.12	7.69 0.12	
					~	<b>6</b>				7.69 0.12			
						Œ	FUER	FILE		0.65 0.220	0.65 0.220	0.65 0.220	
	Ĕ		-C-0097	ROOK	/#z	-	OUTER						
	sulatio		4CA21-91	RRY SEAE	\$3.05 / ft2		SURFACI	AREA	Ę	300	167	133	
OCATION: FOR GILLEM	ECO: 1 - Duct Insulation		CLIENT CONTRACT NO: DACA21-91-C-0097	CLIENT PROJECT ENG: TERRY SEABROOK	UNIT CONST COST:		BLDG, DUCT   SURFACE OUTER INNER	LENGTH	2	45	25	10	
Z: .Z	<u> </u>		CONTRA	PROJEC	IT CONS		E C	PER.	E	8	8	160	
2 2 2 2 2 3 3	ECO:		CLIENT (	CLENT	Š		BLDG.	**		G101	G735		TOTAL

DELTA

15.6 15.6

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT McPHERSON

EMC PROJECT: #3105.000

FILE: ECO-1DG.WK3 PREPARED BY: CMD CHECKED BY: CEL

DATE: 10-JUL-92

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

UNIT CONST

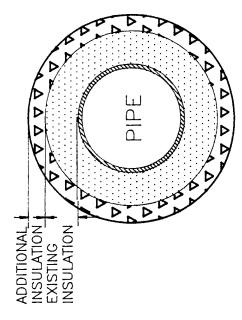
\$3.05 / ft<sup>2</sup>

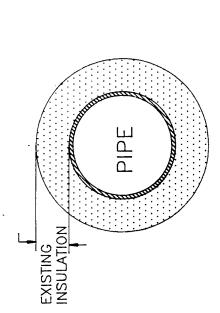
**NEW DUCT INSULATION CONDITION** 

TOTAL CONST COST (\$) \$915.00 \$508.33 \$406.67 \$915.00 (kW/yr) 825.7 2094.5 1675.6 3770.2 ENERGY SAVINGS
GAS ELECTRIC ANNUAL (MBtu/yr) 6.3 17.5 14.0 31.6 (KW/yr) 134.2 531.5 425.2 ELECTRIC ANNUAL 3.3 (MBtu/yr) GAS 0.03 0.12 TOTAL **8** 0.08 SUMMER EAK ESK IMPROVED ENERGY LOSSES (KM) 0.03 0.02 INSRI 700.7 950.1 760.1 TOTAL (Brum) 560.8 448.6 WINTER (Brum) LEAK 700.7 311.4 (Bru/h) INSE BLDG G735 TOTAL G101

Project R. Machanon & F. Glaine   Project Control of Charles   Project C	COST ESTIMATE ANALYSIS	NALY	SIS			-	NVITATION NO.	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	Ω.
No. 01   Markey   M							DACA 21-9	1-C-0097			DATE APR 9	2	22-Apr-92	
Colored   Colo		φ					X CODE A	CODE B	CODEC		DRAWING NO	<u>.</u>		
Colonality   Col					-		OTHER				FSTIMATOR	BMG	CHECKED BY	SE
No. Old   Mith   Total   Tot		(						MOHITO	FNT	MATER	IAL	TOTAL	NIddiHS	G
Unite         Mater         Unite         From         Cont         Price         Cont         Price         Cont         Price         MATER         MAT	NOE A STANLING IN	No. Of	冟	Ì	Total	S E		Unit		Unit			Unit	Total
1   F   0.064   0.064   52.08   51.75   52.28   52.2	TASK DESCRIPTION	5		Unit	Ę	Price	Cost	Price	Cost	Price	Cost		*	\$
1   F   0.08   0.08   50.08   51.07   51.39	1.1 5" INSUI ATION FITS 2" PIPE	_	<u>"</u>	0.084	0.084	\$20.88	\$1.75			\$2.82	\$2.82	\$4.57		
1   F   0.084   0.084   \$1.96   \$1.96   \$1.96   \$2.08   \$1.20   \$1.0	'2" INSIII ATTON EITS 1" PIPE		-	90.0	0.08	\$20.88	\$1.67			\$3.59	\$3.59	\$5.26		
1   F   0.008   \$20.08   \$11.07   \$23.08   \$51.08   \$23.08   \$23.08   \$23.08   \$23.08   \$23.08   \$23.09   \$21.09   \$20.08   \$20.08   \$22.09   \$22	THE STATE OF THE S			0.094	0.094	\$20.88	\$1.96	:		\$3.20	\$3.20	\$5.16		
1   F   0.114   520.88   52.28   53.94   55.18   53.05   53.	THE POST OF THE PLANT OF THE PL		-	0.08	0.08	\$20.88	\$1.67			\$2.60	\$2.60	\$4.27		
1   F   0.093   0.093   \$2.088   \$1.94   \$4.318   \$4.31	THE STANDING THE PLANT OF THE P		+	0.114	0.114	\$20.88	\$2.38			\$3.65	\$3.65	\$6.03		
1   F   0.133   \$2.088   \$2.21   \$2.391   \$2.3	HOLLA LINGUIST OF PIPE		+	0.093	0.093	\$20.88	\$1.94			\$3.19	\$3.19	\$5.13		
1   F   0.106   520.88   51.59   52.29   52.	C. TOUR DATION FITS 4" PIPE		<u>-</u>	0.133	0.133	\$20.88	\$2.78			\$4.36	\$4.36	\$7.14		
1   F   0.076   \$20.88   \$1.67   \$1.59   \$1.29   \$1.29   \$1.28   \$1.58   \$1.	2.3 MOSEATION FITS 3" PIPE		<u>"</u>	0.106	0.106	\$20.88	\$2.21			\$3.91	\$3.91	\$6.12		
1	1 5" INSUITATION FITS 1" PIPE		+	0.076	0.076	\$20.88				\$2.29	\$2.29	\$3.88		
E 1 LF 0.144 \$20.88 \$2.53 \$5.55 \$5.5	4 INSTITUTION FITS 2" PIPE		+-	0.08	0.08	\$20.88				\$1.58	\$1.58	\$3.25		
E 1   F 0.121 \$20.88 \$25.53 \$4.71 \$4	2 INCIDENTAL STORY		_	0.144	0.144	\$20.88	\$3.01			\$5.55	\$5.55	\$8.56		
1	3" INSUITATION FITS 35" PIPE			0.121	0.121	\$20.88	\$2.53			\$4.71	\$4.71	\$7.24		
15%   \$27.00   \$44.64   \$67.00   \$44.64   \$67.00   \$45.10   \$67.00   \$65.20   \$65.	25*INSUI ATION 15* PIPE		5	0.088	0.088	\$20.88	\$1.84			\$3.19	\$3.19	\$5.03		
TAL  TAL  EAD, BOND  10%  10%  10%  10%  10%  10%  10%  10								,						
TAL TAL SEAD, BOND 10% 10% 10% 10% 10% 10% 10% 10% 10% 10%														
TAL  EAD, BOND  EAD, BOND  10%  827.00  EAL 64.64  844.64  840.6  EAL 64.05														T
TAL  EAD, BOND  EAD, B											,			
TAL  EAD, BOND  FAD, B														
TAL  EAD, BOND  EAD, B														
TAL EAD, BOND TAR EAD, BOND TA														
TAL \$27.00 \$44.64 \$56.70 \$44.64 \$56.70 \$56.17 \$10% \$56.17 \$10% \$56.17 \$10% \$56.17 \$10.00 \$10.														
TAL EAD, BOND EAD, BOND 15% 844.64  EAD, BOND 15% 15% 10% 827.00 844.64 847.6  844.64 844.6 844.														
TAL       \$27.00       \$44.64         EAD, BOND       15%       \$4.05       \$4.46         SUB-TOTAL       \$53.75       \$6.70       \$4.46         SUB-TOTAL       \$5.06       \$5.00       \$5.00         QENCY       \$5.06       \$5.00       \$5.00         \$5.00       \$5.00       \$5.00       \$5.00         \$5.00       \$5.00       \$5.00       \$5.00         \$5.00       \$5.00       \$5.00       \$5.00         \$5.00       \$5.00       \$5.00       \$5.00         \$6.17       \$5.00       \$6.17       \$5.00			_											
TAL       \$27.00       \$44.64         EAD, BOND       15%       \$4.05       \$6.70         SUB-TOTAL       \$33.75       \$6.30       \$4.46         \$10%       \$2.70       \$4.05       \$4.46         \$2.70       \$4.05       \$6.70         \$2.70       \$4.6       \$4.6         \$4.6       \$5.00       \$5.83         \$5.00       \$5.00       \$5.50         \$6.17       \$64.17														
TAL     \$27.00     \$44.64       EAD, BOND     15%     \$4.05     \$4.05       SUB_TOTAL     \$2.70     \$4.66     \$4.46       SUB_TOTAL     \$5.00     \$5.00     \$5.00       IQENCY     \$5.00     \$5.00     \$5.00		_	-											
TAL         \$27.00         \$44.64           EAD, BOND         15%         \$4.05         \$6.70           SUB-TOTAL         \$33.75         \$6.37         \$6.37           IQENCY         15%         \$5.06         \$6.37           \$6.4.17         1         \$64.17         \$64.17														
TAL         \$27.00         \$44.64           EAD, BOND         15%         \$4.05         \$6.70           SUB-TOTAL         \$33.75         \$5.83         \$5.83           IQENCY         15%         \$5.06         \$55.80           \$5.06         \$5.06         \$55.80         \$55.80           \$64.17         \$58.37         \$64.17         \$64.17														
TAL         \$27.00         \$44.64           EAD, BOND         15%         \$4.05         \$6.70           SUB-TOTAL         \$33.75         \$55.80         \$55.80           IQENCY         \$38.81         \$64.17         \$64.17														
EAD, BOND         15%         \$4.05         \$6.70           SUB-TOTAL         \$2.70         \$4.46         \$5.80           SUB-TOTAL         \$5.06         \$6.4.17         \$64.17	SUBTOTAL						\$27.00				\$44.64	$\perp$		
SUB-TOTAL         \$2.70         \$4.46           SUB-TOTAL         \$33.75         \$55.80           IGENCY         \$5.06         \$64.17	OVERHEAD, BOND	159	9				\$4.05				\$6.70			
SUB-TOTAL         \$33.75         \$55.80           IGENCY         \$38.81         \$64.17	PROFIT	-01	<b>.</b>				\$2.70				\$4.46			
IGENCY 15% \$5.06 \$8.37	COST SUB-TOTAL						\$33.75				\$55.80	$\perp$		
\$38.81	CONTINGENCY	159	<b>9</b>				\$5.06				\$8.37	T.		
	TOTAL				į		\$38.81				\$04.1			

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem  Quantity  DUCT INSULATION  TASK DESCRIPTION  TASK DESCRIPTION  TASK DESCRIPTION  TASK DESCRIPTION  TASK DESCRIPTION  TASK DESCRIPTION  TOTAL  TO	0.058 Unit		X CODE A CODE	8	CODEC	DRAWING NO.	g.	SH OF	
Cuantity No. Of Unit Units Meas	Unit Unit		OTHER						
Ouantity No. Of Unit Units Meas	Unit Unit	— წ —							
Cuantity No. Of Unit Units Meas	Unit Unit	<del> </del>				ESTIMATOR HMG	HAMG	CHECKEUBY CE	Д
No. Of Units Meas	Unit Unit 0.058			EQUPMENT		MATERIAL	TOTAL	SHIPPING	
Units Meas	Unit 0.058							ž *	Total ≰
T. S.		S LUCB	Cost	Price	Cost	00 NOST			
T									
		\$20.88	\$1.21		•	\$0.90	0 \$2.11		
JOINT SEALING									
JOINT SEALING									
	-								
					+				
					_				
					+				
					1				
						9	60 11	-	
STOTAL	•	\$0.06	\$1.21			90		- 0	
SUBJUST 15%	47	\$0.01	\$0.18			\$0.1\$			
ONCO 'ONCO		<b>\$0.03</b>	\$0.12			\$0.08			
		\$0.07	\$1.51			\$1.13			
JIAL.		808	88			\$0.17		0	
CONTINGENCY		10.00	2 2		_	\$1.28	\$3.03	<u>ව</u>	





### ADDITIONAL INSULATION

FLUID		PIPE	SIZE	PIPE SIZE (inches)	
	0.25-	1.25- 2.00	2.25- 3.00	3.25- 4.00	4.25- 5.00
CHILLED WATER PIPES					
Fiberglass	0.50	0.75	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					1.50
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES					
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS			All Sizes		
		2"	Fiberglass		

APPENDIX C-2
INSULATED GLASS

### INSULATED GLASS SAMPLE CALCULATION, ECO #2 BUILDING 505 (GILLEM)

### Given:

# of Windows = 127 windows - from bldg plans / survey notes = 3.387 ft- 3,30/ It vvindow Area = 6,468 ft<sup>2</sup> Gas Savings Factor = 0.0031 MBtu / ft<sup>2</sup> Electric Savings Factor = 0.68 kWh / ft<sup>2</sup> Demand Savings Factor = 0.0 kW - from bldg plans / survey notes Window Perimeter - from bldg plans / survey notes - from Bldg 100 simulation - from Bldg 100 simulation - from Bldg 100 simulation - from utility rate analysis = \$4.67 / MBtu Gas Cost - from utility rate analysis Electric Cost = \$0.0255 / kWh- from utility rate analysis Demand Cost = \$8.85 / kW

### Peak Demand Savings:

 $(6,468 \text{ ft}^2)^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

### **Annual Energy Savings:**

- Gas:  $(6,468 \text{ ft}^2)^*(0.031 \text{ MBtu}/\text{ft}^2) = 201 \text{ MBtu}$ - Electric:  $(6,468 \text{ ft}^2)^*(0.68 \text{ kWh}/\text{ft}^2) = 4,398 \text{ kWh}$ 

### **Annual Cost Savings:**

 $(201 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (4,398 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$1,049 / \text{ yr}$ 

### **Estimated Construction Cost:**

\$19.37 / each window demolition - from engineer's cost estimate - from engineer's cost estimate

(\$19.37 / ea)\*(127 win) + (\$31.57 / ft)\*(3,387 ft) = \$109,377

\$109,377 + (\$109,377 \* .055 SIOH) + (\$109,377 \* .06 DESIGN) = \$121,955

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 2 - Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

FILE: ECO-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

EMC PROJECT: #3105.000

16-Jul-92

DATE:

15.61 UPWE 14.53 UPW FACTOR 23.77 UPWG DISCOUNT \$4.67 / MBtu \$0.0255 / KWh \$8.85 / kW ENERGY COST Economic Life: 25 yrs Demand Savings Electric Savings Gas Savings

							ANNUAL				
# UU 18	PEAK DEMAND	ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNUAL	NON-	TOTAL	FONCO	Ş	L
k 5	SAVINGS	SAVINGS SAVING	SAVINGS		SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	LIO.	PAYBACK
	(kW)	(kWh/yr) (MBtu/	YT)		(\$/ <b>y</b> r)	(\$/yr)	(\$/vr)	(\$/vr)	9		(vrs)
202	0	4,398	201	216	1,049	<b>9</b>	<b>9</b>	\$1,049	\$1,049 \$121,955	0.2	116
206	0	4,398		216	1,049	<b>₩</b>	<b>&amp;</b>	\$1,049	\$1,049 \$121,955	0.2	116
202	0	4,398	201	216	1,049	<b>₩</b>	8	\$1,049	\$1,049 \$121,955	0.2	116
508	0	4,398	201	216	1,049	<b>Ş</b>	8	\$1,049	\$1,049 \$121,955	0.2	116
209	0	4,398	201	216	1,049	<b>₩</b>	8	\$1,049	\$1,049 \$121,955	0.2	116
510	0	4,398	201	216	1,049	<b>Ģ</b>	<b>&amp;</b>	\$1,049	\$1,049 \$121,955	0.2	116
511	0	4,398	201	216	1,049	<b>&amp;</b>	<b>9</b>	\$1,049	\$1,049 \$121,955	0.2	116
512	0	4,398	201	216	1,049	<b>₩</b>	<b>9</b>	\$1,049	\$1,049 \$121,955	0.2	116
513	0	4,398	201	216	1,049	<b>₩</b>	<b>\$</b>	\$1,049	\$1,049 \$121,955	0.2	116
514	0	4,398	201	216	1,049	<b>S</b>	<b>9</b>	\$1,049	\$1,049 \$121,955	0.2	116
101	6	3,363	123	134	099	\$930	<b>₩</b>	\$1,589	\$183,878	0.2	116
202	0	999	90	EE	158	S S	<b>8</b>	\$158	\$31,125	0.1	197
735	0	(6)	1	1	9	\$	\$0	<b>\$</b> e	\$2,751	0.1	455

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 2 - Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

FILE: EC0-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY: DATE: 15-APR-92

EMC PROJECT: #3105.000

-							PEAK	ANNOAL	ANNOAL		=======================================	10.1AL
BLDG *	*	Z	Z	DEMAND	ELECTRIC	GAS	DEMAND	ELECTRIC	GAS	DEMO	CONST	CONST
 	Z	PERIM	AREA	SAVINGS		SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	COST	COST
		£	(ft ^ 2)	(KW/ft²)	(kWh/ft²)	(MBtu/ft²)	(kW)	(kWh/yr)	(MBtu/yr)	(\$/ea)	(\$/ft)	(\$)
101	231	5,082	6,468	0.0014	0.52	0.019	9.1	3,363	123	\$19.37	\$31.57	\$164,913
207	46	856	926	0	0.68	0.031	0	665	30	\$19.37	\$31.57	\$27,915
505	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
506	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
507	127		6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
508	127		6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
509	127		6.468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
510	127		6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
511	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
512	127		6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
513	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
514	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
735	7		29	0	-0.13	0.020	0	(8.7)	1.3	\$11.83	\$26.89	\$2,467

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 2 - Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 21-APR-92

FILE: EC0-2.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

						TOTAL	TOTAL	TOTAL
BLDG #	#	LENGTH	WIDTH	AREA	PERIM	AREA	PERIM	#
	WIN	(in)	(in)	(ft²)	(ft)	(ft²)	(ft)	WIN
101	231	84	48	6468	5082	6468	5082	231
207	30	72	48	720	600	976	856	46
	16	48	48	256	256			
505	127	52	108	4953	3387	6468	3387	127
506	127	52	108	4953	3387	6468	3387	127
507	127	52	108	4953	3387	6468	3387	127
508	127	52	108	4953	3387	6468	3387	127
509	127	52	108	4953	3387	6468	3387	127
510	127	52	108	4953	3387	6468	3387	127
511	127	52	108	4953	3387	6468	3387	127
512	127	52	108	4953	3387	6468	3387	127
513	127	52	108	4953	3387	6468	3387	127
514	127	52	108	4953	3387	6468	3387	127
735	2	53	30	22	28	67	89	7
	3	54	30	34	42			
	2	30	27	11	19			

A STAMITON TOO	NAIN	210				NOTATION N	INVITATION NO./CONTRACT NO.	Ó		EFFECTIVE PRICING	PICING	DATE PREPARED	
COSI ESTIMATE ANALISIS		5				DACA 21 -	DACA 21-91-C-0097			DATE APR 92	22	₹	
DEO IECT Et McPherson & Ft. Gillem ESOS Study	ybu					X CODE A	CODEB	CODEC		DRAWING NO.	o.	SHT OF	
٦,						OTHER				ESTIMATOR RMG	PMG	CHECKED BY	
								FA	MATERIAL	SIAI	TOTAL	SHIPPING	g
	Quantity	Tity		LABOR	- 1							ticl 1	Total
ECO 2 - Insulated Glass, Aluminum	5 €			Total	ig ;		Chit	Š	D G	Cost		<u></u> ₹	₹
TASK DESCRIPTION	Sirgs	Meas		Hrs	Price	3	LICA	3	2		\$13.47		
ALUMINUM DEMOLTION		ā	0.727	0.727	\$18.53						\$13.47		
SUBTOTAL						\$13.47					\$2.02		
OVERHEAD, BOND	15%					\$2.CK					8.13		
PROFIT	ş					S. 18					\$16.84		
COST SUB-TOTAL						10.01					\$2.53		
CONTINGENCY	15%					\$2.5¢					\$19.37		
TOTAL					-	\$18.5\							
			1	2	┷	80 69			\$19.00	\$19.00	\$21.96		
ALUMINUM CASEMENT (awning)	-	5	9.16	20	9 00						\$21.96		
SUBTOTAL						\$6.36		-			\$3.23		
OVERHEAD, BOND	15%					\$ C					\$2.20		
PROFIT	10%					S.03					\$27.46		
COST SUB-TOTAL						\$3.71					2		
CONTINGENCY	15%	-9				\$0.56		-			\$31.57		
TOTAL					_	<b>27</b>							
			_										
	_		1										
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COST ESTIMATE ANALYSIS	NAL	(SIS				NVITATION NC	INVITATION NO./CONTRACT NO.	C.		EFFECTIVE PRICING	RICING	DATE PREPARED	<u></u>
						DACA 21-	DACA 21-91-C-0097			DATE APR 92	Ŋ	-Apr	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	λ					X CODE A	CODEB	CODEC		DRAWING NO.	o.	SHT OF	
-						OTHER							
										ESTIMATOR PMG	PMG	CHECKEDBY	
	Quantity	-dity		LABOR	Œ		EQUPMENT	ENT	MATERIAL	JAI.	TOTAL	SHIPPING	ပ
ECO 2 - Insulated Glass, Wood	₹ 5	Cnit	¥	Total	Ç		Cait		, C			tic :	Total
TASK DESCRIPTION	Chits	Meas	Ç	Hrs	Price	Cost	Price	Sost	Price	Set		*	₹
WOOD DEWOLTION	-	Æ	0.444	0.444	\$18.53	\$8.23					\$8.23		
SUBTOTAL						\$8.23					\$8.23		
OVERHEAD BOND	15%					\$1.23					\$1.23		
РВОЕТ	20%					\$0.82					\$0.82		
COST SUB-TOTAL						\$10.28					\$10.28		
CONTINUENCY	15%					\$1.54					2.12 22.		
TOTAL						\$11.83					\$11.83		
WOOD CASEMENT	-	5	0.200	0.200	\$18.53	\$3.71			\$17.00	\$17.00	\$20.71		
SIBTOTAL						\$3.71					\$20.71		
OVERHEAD BOND	15%					\$0.56					\$3.11		
Hadda	£					\$0.37					\$2.07		
COST SUB-TOTAL						\$4.63					\$25.88		
CONTINGENCY	15%					\$0.68					\$3.88		
TOTAL						\$5.33	,				\$29.76		
(bunkle liding) (Sivilation bund)	-	5	0.2	0.200	\$18.53	\$3.71			\$15.00	\$15.00			
SUBTOTAL						\$3.71					\$18.71		
OVERHEAD BOND	15%					\$0.56					\$2.81		
PROFIT	10%					\$0.37					\$1.87		
COST SUB-TOTAL						<b>3.</b>					\$23.38		
CONTINGENCY	15%					\$0.68					\$3.51		
TOTAL						\$5.33		-			\$26.89		

### APPENDIX C-3 WEATHERSTRIPPING AND CAULKING

### WEATHERSTRIPPING & CAULKING SAMPLE CALCULATION, ECO #3 BUILDING 111

### Given:

Stack coefficient(A)	= 0.016	-from ASHRAE Table F 23.7
Wind coefficient(B)	= 0.0039	-from ASHRAE Table F 23.7
Avg. temperature diff.	$= 72 - 55 = 17^{\circ}F$	-from Atlanta weather data
Avg. wind speed	= 12.65  mph	-from Atlanta weather data
# of windows	= 24 windows	-from bldg plans / survey notes
Window area	$= 380 \text{ ft}^2$	-from bldg plans / survey notes
Exist. window leakage coef.		-from ASHRAE Table F 23.3
Exist. frame leakage coef.	$= 0.093 \text{ in}^2/\text{ft}^2$	-from ASHRAE Table F 23.3
Imp. window leakage coef.	$= 0.026 \text{ in }^2/\text{ft}^2$	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	$= 0.019 \text{ in }^2/\text{ft}^2$	-from ASHRAE Table F 23.3
	= 3 doors	-from bldg plans / survey notes
# of doors	$= 52 \text{ ft}^2$	-from bldg plans / survey notes
Door area	$= 0.157 \text{ in}^2/\text{ft}^2$	-from ASHRAE Table F 23.3
Exist. door leakage coef.	$= 0.137 \text{ in }^{7} \text{ ft}^{2}$ = 0.072 in $^{2}/\text{ft}^{2}$	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	$= 0.072 \text{ in } / \text{ft}^2$ = 0.114 in $^2/\text{ft}^2$	-from ASHRAE Table F 23.3
Imprv. door leakage coef.	$= 0.0143 \text{ in}^2/\text{ft}^2$	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.0145  H t / 10 = 440 ft	-from bldg plans / survey notes
Total door/win perimeter	= 0.025 MBtu/cfm	-from Bldg 100 simulation
Gas savings factor	= 5.8  kWh/cfm	-from Bldg 100 simulation
Electric savings factor	= 0.0  kW/cfm	-from Bldg 100 simulation
Demand savings factor		-from utility rate analysis
Gas Cost	= \$4.67/MBtu	-from utility rate analysis
Electric Cost	= \$0.0255/kWh	-from utility rate analysis
Demand Cost	= \$8.85/kW	-Hom dunty rate analysis

### Existing Effective Leakage Area:

$$(.052 + .093 \text{ in}^2/\text{ft}^2)^*(380 \text{ ft}^2) + (.157 + .072 \text{ in}^2/\text{ft}^2)^*(52 \text{ ft}^2)$$
  
= 66.9 in<sup>2</sup>

### **Existing Window / Door Infiltration:**

$$66.9*(0.016*(17) + .0039*(12.65^2))^1/2 = 63 \text{ cfm}$$

### Improved Effective Leakage Area:

$$(.026 + .019 \text{ in}^2/\text{ft}^2)^*(380 \text{ ft}^2) + (.114 + .0143 \text{ in}^2/\text{ft}^2)^*(52 \text{ ft}^2)$$
  
= 23.7 in<sup>2</sup>

### Improved Window / Door Infiltration:

$$23.7*(0.016*(17) + .0039*(12.65^2))^1/2 = 22 \text{ cfm}$$

### Delta infiltration:

$$63 - 22 = 41$$
 cfm

### Peak Demand Savings:

$$(41 \text{ cfm})^*(0.0 \text{ kW} / \text{cfm}) = 0.0 \text{ kW}$$

### **Annual Energy Savings:**

- Gas:  $(41 \text{ cfm})^*(0.025 \text{ MBtu / cfm}) = 1.02 \text{ MBtu}$ - Electric:  $(41 \text{ cfm})^*(5.8 \text{ kWh / cfm}) = 187 \text{ kWh}$ 

### **Annual Cost Savings:**

$$(1.02 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (187 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + 0.95 * 8) = \$10 / \text{yr}$$

### **Estimated Construction Cost:**

\$53.00 / window -from engineer's cost estimate \$114.17 / door -from engineer's cost estimate \$1.18 / ft of perimeter -from engineer's cost estimate

(\$53.00 / ea)\*(24 win) + (\$114.17 / ea)\*(3 doors) + (\$1.18/ ft)\*(440 ft) = \$2,133

\$2,133 + (\$2,133 \* .055 SIOH) + (\$2,133 \* .06 DESIGN) = \$2,378

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 3 - Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY DISCOUNT
COST FACTOR
Gas Savings \$4.67 / MBtu 23.77 UPWG
Electric Savings \$0.0255 / kWn 15.61 UPWE
Demand Savings \$8.85 / kW 14.53 UPW
Economic Life: 25 yrs

EMC PROJECT: #3105,000 DATE: FILE: ECO-3.WK3 PREPARED BY: R. GERRANS CHECKED BY:

		¥		2	8	13	13	13	5	5	13	3	5	<del>1</del> 3	13	9
	SIMPLE	PAYBACK	(yrs)													
	SIR			1		0.1										
	NST	COST	<b>3</b>	21,926	13,756	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	20,750	\$1,474
	පි	<u>ა</u>		3	3	9	9	9	\$ 9	\$ 9	\$ 9	\$ 9	9	9	\$ 9	2
TOTA	ANNUAL CO	SAVINGS	(\$/vr)	<b>83</b> 1	£3	<b>₩</b>	<b>\$</b> €	<b>\$</b> 6	9\$	9 <b>\$</b>	9\$	9\$	\$6	9	9\$	49
NOAL NO	ERGY	INGS	(/Vr)	<b>₩</b>	<b>₽</b>	တ္ဆ	<b>₩</b>	<b>&amp;</b>	\$0	<b>\$</b>	<b>0\$</b>	0\$	\$0	<b>₩</b>	<b>9</b>	န
ANNIA	DEMAND EN	SAVINGS	(\$/yr)	\$208	0\$	\$	0\$	0\$	\$0	0\$	0\$	\$0	\$0	0\$	0\$	83
ANNITAL	ENERGY	NGS	Vr)	\$105	ğ	99	9\$	9\$	9\$	<b>39</b>	19\$	<b>\$</b> 6	19\$	19\$	9	ij
TOTA	ENERGY	SAVINGS	(MBtu/yr)		8	14										
ANIMIA	ı	SAVINGS	(MBtu/yr)	-		13										
1	ELECTRIC	S	3		178	307	307	307	307	307	307	307	206	307	307	10
	DEMAND	SAVINGS			0	0	0	0	0	0	0	0	0	0	0	0
	BLDG #				202	505	206	202	208	209	510	511	512	513	514	735

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: 3 - Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 15-APR-92

	ANNUAL C	- - - - - -
ANNUAL ELECTRIC		PEAK DEMAND
PEAK ANNUAL ANNUAL DEMAND ELECTRIC GAS	PEAK	GAS
PEAK	PEAK	LECTRIC
PEAK	PEAK	EMAND
PEAK GAS DEMAND	PEAK	■ ■

				HO					PEAK	ANNUAL	ANNUAL	L N O	LINO CNI	LNS		
# 50 IB	TOTAL	*	*	DOORS	DEI TA	DEMAND	FLECTRIC	GAS	DEMAND	ELECTRIC	GAS	CONST	CONST	CONST		CONST
DEBIN	PERIM	2	DOORS	PFRIM	IN I	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	COST	COST	COST	COST
		•	)	€	(cfm)	(kW/cfm)	(kWh/cfm)	(MBtu/cfm)	(KW)	(kWh/yr)	(MBtu/yr)	(\$/ft)	(\$/win)	(\$/door)		(\$)
101	5322	231	10		752	0.0027	0.89			699	18.8	\$1.18	\$53.00	\$114.17		\$19,665
207	1600	92	12	504		0	0.27		0		_	\$1.18		\$114.17	!	\$12,337
505	4305	128	10			0	0.27				_	\$1.18		\$114.17		\$18,610
506	4305	128	10		1137	0	0.27				_	\$1.18		\$114.17		\$18,610
507	4305	128	10			0	0.27		0	307		\$1.18		\$114.17		\$18,610
50g	4305	128	10			0	0.27		0	307	_	\$1.18		\$114.17		\$18,610
200	4305	128				0	0.27	0.011				\$1.18		\$114.17		\$18,610
510	4305	128				0	0.27				•	\$1.18		\$114.17		\$18,610
511	4305	1_	10			0	0.27		0	307		\$1.18		\$114.17		\$18,610
512	4305		100			0	0.27	0.011	0			\$1.18		\$114.17		\$18,610
513	4305	L	10		Ĺ	0	0.27		0	307	12.5	\$1.18		\$114.17	\$8.34	\$18,610
514	4305	L	10		Ĺ	0	0.27		0			\$1.18		\$114.17	\$8.34	\$18,610
735	225		9			0.0027		0.025	0.03	10	0.3	\$1.18	\$53.00	\$114.17	\$8.34	\$1,322

PROJECT: FORT MePHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: 3 - Weatherstripping & Caulking

CLIENT CONTRACT NO. DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

													N.	NIX		•	į	000	2000	_	•
STORIES A B WALL # GLASS WIN INFIL CONST. WIN. TYPE TYPE DESCRIP	<b>6</b>		WALL #	* <u>X</u>		GLASS TYPE	WIN	INFIL DESCRIP		WIN FRAME L W (in²/ft²) (in²/ft²) (in) (in)	<u>ي</u> د	€ (E	PEHIM AHEA (ft) (ft²)	AHEA (ff2)	(in²)	DOORS	DOORS DESCRIP			J (E)	: E
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1 0.016 0.004 FIRME 2 SI				2 6	<u> </u>		<u> </u>	30	0.026	ı	1	1			-	2	2 High	0.157	0.024	90	64
		000	000	000	ü		ā	30	9000					=	0	_	Med	0.157	0.024	2	္က

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 3 - Weatherstripping & Caulking

CLIENT CONTRACT NO. DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

3LDG	DOOR	DOOR		2	IMPRV	IMPRV	IMPRV	IMPRV	IMPRV	EXIST	IMPRV	DELTA	TOTAL	*	*	DOORS
*	PERIM	AREA Leff	L off	L off	Z Š	_=	DOOR			INFIL	INFIL	INFIL	PERIM	Z	DOORS	PERIM
	Œ	(#2)	(int)	(in²)	(in*/ft*)	(in*/ft²)	(in2/ft2)	(in²/ft²)	(in²)	(ctm)	(cfm)	(ctm)	Œ			€
101										11989	11237	752	5322	231	10	
207												099	1600	92	12	504
505												1137	4305	128	10	672
506												1137		128	10	672
507												1137	4305	128	10	
508												1137		128	10	672
509												1137	4305	128	10	672
510												1137	4305	128	10	
511												1137	4305	128	10	
512												1137	4305	128	10	672
513												1137	4305	128	10	672
514												1137	4305	128	10	672
735	72	107	19	36.8	0.026	0.004	0.114	0.004	24.7	35	23	11	225	7	9	
	48	71	13													
	17	15	က													

SISY IANA TEMITE TOO	NAI	Sic			_ ≤	IVITATION NC	INVITATION NO./CONTRACT NO.	ó		EFFECTIVE PRICING	RICING	DATE PREPARED	Ω
COSI ESITAVIE A		)				DACA 21-	DACA 21-91-C-0097	i		DATE APR 92	12	15-Apr-92	
PEO IFOT Ft McPherson & Ft. Gillem ESOS Study	Apr					X CODE A	CODEB	CODEC		DRAWING NO.	o.	SHT OF	
12						OTHER			-	ECTAMATOR PAAG	DWG.	CHECKED BY	
												I COLLEGE	
	Quantity	Ą		LABOR	<b>C</b> -		EQUIPMENT		MATEHIAL	₹	₫	DNILLIIN	5 1
COO Monthamptonia & Caulking	S.	Ę	¥	Total	Chit		Unit		ב ב			<u></u> = = = = = = = = = = = = = = = = = = =	lota
HOUSE WASHINGTON	Units	Meas	Ę	Hrs	Price	Cost	Price	Š	Price	Cost		ž	ž
ASK DESCRIPTION	+	ш	8,10	0.178	\$18.53	\$3.30			\$2.50	\$2.50	\$5.80		
ASTRAGAL, OVERHEAD DOOR	-		2			\$3.30					\$5.80		
SUBTOTAL	į					\$0.49					\$0.87		
OVERHEAD, BOND	15%					2 5					\$0.58		
PROFIT	\$					54 15					\$7.25		
COST SUB-TOTAL						50 60					\$1.09		
CONTINGENCY	15%					2.25					\$8.34		
TOTAL						1							
			1	,	910 53	£20.57		-	\$16.30	\$16.30	\$36.87		
WEATHERSTRIPPING, WINDOW	-	ð	1.10	2	20.0	#KU.37							
SUBTOTAL						\$20.37					\$5.53		
OVERHEAD, BOND	15%					83.CB					23.69		
PROFIT	10%					\$2.06					\$46.00		
COST SUB-TOTAL						\$25.71					5		
CONTINGENCY	15%					83.58		-			\$5300		
TOTAL						\$29.57							
									500	63000	¢79.42		
WEATHERSTRIPPING, DOOR	-	ā	2.7	2.667	\$18.53	\$49.42			37.00		1_		
SIBTOTAL						\$49.45					6119		
OVERHEAD, BOND	15%					\$7.41		+			2 2		
PROFIT	±					3.		-			2000		
COST SUB-TOTAL						\$61.77					\$14.89		
CONTINGENCY	15%					39.2/					\$114.17		
TOTAL						\$1.5¢							
		-		100	1	1300		-	80.03	\$0.25	\$0.82	O	
CAULKING, SILICONE		5	0.03	3.0	D A						_	61	
SUBTOTAL						5 6					\$0.12	0.1	
OVERHEAD, BOND	15%					90.06					80.08		
PROFIT	<del>ر</del> ه		_			20.02		-			5		
COST SUB-TOTAL						\$0.72		+			\$0.55	1.00	
CONTINGENCY	15%		_			\$0.11					18		
TOTAL						80.83					•		
			_										

	E	M	С	Ε	NGINE	E	RS, I	N	C.
Denver	•	Cold	orac	lo	Springs	•	Atlanta	•	German

<sub>JOB</sub> #3105.000	FT. MCPHERSON,	/GILLEM
SHEET NO.		OF
CALCULATED BY	CEL	DATE 7/20/92
CHECKED BY		DATE
SCALE	NONE	

Weatherstripping cost estimates taken from <u>MEANS BUILDING CONSTRUCTION</u> COST DATA 1992

Overhead doors:

- Interlocking aluminum, 5/8" x 1" neoprene bulb insert.

Windows:

- Bronze weatherstripping for  $3' \times 5'$  double hung window.

Personnel doors:

- Metal frame, bronze weatherstripping, spring type.

### APPENDIX C-4 MEASURE HOT WATER TEMPERATURES

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 4 - Domestic Hot Water Temperatures

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 15-APR-92 FILE: ECO-4.WK3

PREPARED BY: CHRIS STANLEY

CHECKED BY:

BLDG		LOCATION OF BLDG.	HOT WTR
#	DESCRIPTION		(°F)
101	ADMINISTRATION	Mech Room, Basement, W	150
		Men's Bathroom, Flr 1, W	141
102	MAINTENANCE	Men's Bathroom, S	128
		Woodshop Sink	138
103	FIRE STATION	AHU Room Sink	133
		Bathroom	134
133	OFFICERS CLUB	Men's Bathroom, N.E.	155
		Kitchen	152
207	STORAGE	Faucet, Bay 1	142
		Men's Bathroom, Bay 3	142
		Break Room	125
213	CID BUILDING	Men's Bathroom, Bay 5	122
	COMMISSARY	Men's Bathroom, S	139
		Break Room, Middle of Bldg	130
		Vegetable Cleaning Room	146
308	STORAGE	Men's Bathroom, N	140
		Men's Bathroom, S.E.	131
400	DOL	Men's SHOWER, N.E.	96
		Paint Room, Sink	92
		Sink, SW	104
		Sink, SE	110
401	EIGHTY-FIRST	Bathroom, Downstairs	N/A
		Showers, Upstairs	108
403	DINING FACILITY	Men's Bathroom, SW	120
		NW Mess Hall	136
		Bathroom, N	156
505	STORAGE	Women's Bathroom, E	144
		Men's Bathroom, E	151
512	STORAGE	Men's Bathroom, W, Bay 2	101
		Break Room, NW, Bay 1	129
513	STORAGE	Women's Bathroom, E	144
		Men's Bathroom, E	151
735	THEATER (T)	Men's Bathroom	155
		Women's Bathroom	155
035	FITNESS CENTER	Men's Locker Room	129

### APPENDIX C-5 ELECTRIC MOTORS

LIFE CYCLE COS ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DAC FISCAL YEAR 1992 DISC ANALYSIS DATE: 07-15-92	BETE DODTION	NAME:	ECO-5 H	IGH EFFICIE	NCY 1	
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	т	: - 11	<b>)</b> )		\$ \$ -\$	33322. 1833. 2000. 0. 37155.
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL	COST (-) SAVINGS, UNI	T CO	ST & DISC	COUNTED SAVI	NGS	
UNIT COST FUEL \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANN SAV	UAL \$ INGS(3)	DISCOUNT FACTOR(4)	DIS SAV	<b></b>
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	243. 0. 0. 0.	\$ \$ \$ \$	1816. 0. 0. 0.	15.61 21.66 26.51 23.77 16.06		28341. 0. 0. 0.
F. TOTAL	243.	\$	1816.		\$	28341.
3. NON ENERGY SAVINGS(+)						
A. ANNUAL RECURRING	(+/-)			14 53	\$	1102.
(1) DISCOUNT FACT (2) DISCOUNTED SA	OR (TABLE A) AVING/COST (3)	а х з	A1)	14.53	\$	16012.
C. TOTAL NON ENERGY I					4)\$	16012.
D. PROJECT NON ENERGY  (1) 25% MAX NON I  A IF 3D1 IS  B IF 3D1 IS  C IF 3D1B IS  D IF 3D1B IS	QUALIFICATION CALC ( OUT OF THE CONTROL OF THE CALC OUT OF THE CALC OUT	ON TE 2F5 X O TO SIR O ITE DOES	ST :.33) :ITEM 4 = (2F5+3 :M 4 : NOT QUA	\$ 93: D1)/1E) 1.0	52. 01	
4. FIRST YEAR DOLLAR SA	VINGS 2F3+3A+	(3B1D	/(YRS EC	ONOMIC LIFE	))\$	2918.
5. TOTAL NET DISCOUNTED					\$	44353.
6. DISCOUNTED SAVINGS R (IF < 1 PROJECT DOE	ATIO S NOT QUALIFY	(s ')	SIR)=(5 /	1E)= 1.	19	
7. SIMPLE PAYBACK PERIO	D (ESTIMATED)	S	SPB=1E/4	12.	73	

### HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5 **BUILDING 40**

### Given:

-from field survey = 3 hpMotor Horsepower -from field survey = 8,760 hrs / yrOperation Hours

-from standard motor info Standard Motor Efficiency = 84%

-from high efficiency motor info High Eff Motor Efficiency = 88.5%

-assumed

Motor Load Factor = 85%

Cas Cost = \$4.67 / MBtu -from utility rate analysis -from utility rate analysis = \$0.0255 / kWhElectric Cost -from utility rate analysis = \$8.85 / kWDemand Cost

### **Existing Demand:**

$$(3 \text{ hp}) * (0.746 \text{ kw/ hp}) * (85\%) = 2.26 \text{ kw}$$

$$(84\%)$$

### Improved Demand:

$$(3 \text{ hp}) * (0.746 \text{ kw / hp}) * (85\%) = 2.15 \text{ kw}$$
  
(88.5%)

### Peak Demand Savings:

$$2.26 \text{ kW} - 2.15 \text{ kW} = 0.11 \text{ kW}$$

### **Annual Electric Savings:**

$$(0.11 \text{ kW})^*(8,760 \text{ hrs / yr}) = 964 \text{ kWh / yr}$$

### **Annual Cost Savings:**

$$(0.0 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (964 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.11 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + 0.95 * 8) = \$36 / \text{yr}$$

### **Estimated Construction Cost:**

-from engineer's cost estimate \$624 / 3 hp motor

$$$624 + ($624 * .055 SIOH) + ($624 * .06 DESIGN) = $695$$

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

PREPARED BY: R. GERRANS CHECKED BY:

EMC PROJECT: #3105.000

17-Jul-92

DATE

FILE: ECO-5.WK3

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

4	PEAK	ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNUAL	ANNUAL NON- ENERGY	TOTAL	CONST	SIR	SIMPLE
* 5010	SAVINGS		S		SAVINGS (\$/vr)	SAVINGS (\$/vr)	SAVINGS (\$/vr)	SAVINGS (\$/vr)	COST (\$)		PAYBACK (vrs)
101	4 4 4	╢	0	87	<u> </u>		\$	\$1,106	\$10,132	1.7	9.5
214		10,031	0	34	\$256	\$141	\$0	\$397	\$5,601	1.1	14.1
213	4		0	06	\$674	. \$397	0\$	\$1,071		1.0	
207		5,364	0	18	\$137	. \$63	0\$	\$200	\$3,041	1.0	•
103	0	3.912	0	13	\$100	\$46	\$0	\$146	\$2,259	1.0	15.5
TOTAL		71,225	0	243	\$1,816	\$1,102	0\$	\$2,918	\$37,154	1.2	12.7
512	0	2.461	0	8	\$63	\$29	\$	\$92	\$1,477	0.0	
133	0	3,206	0	11	\$85	\$38	0\$	\$119		6.0	
400		6,557	0	22	\$167	\$146	\$0			0.8	
308	0	4,070	0	4	\$104	\$48	\$0	97		0.8	
102	0	1,585	0	2	\$40	\$19	<b>\$</b> 0				
935		4,171	0	14	\$106	\$ \$72		97			
735	0	727	0	2	\$19	3 \$34	\$0	\$53	\$1,324	9.0	25.2

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

EQUIPMENT   NOTE   SIZED   HP   FLA   VOLTS   EFF   AMPS   PF   VOLT							LOAD			DEMAND		ELECTRIC
SIZED         HP         FLA         VOLTS         EFF         AMPS         PF           30.0         85.0         200         90.6         0.84           30.0         85.0         200         90.6         0.84           30.0         85.0         200         16.0         0.75           OVER         10.0         29.0         208         82.5%         16.7         0.72           10.0         29.0         208         82.5%         16.7         0.72           10.0         3.0         208         82.5%         0.80           10.0         3.0         208         82.5%         0.80           10.0         3.0         20.0         20.0         0.80           10.0         3.0         3.0         11.4         20.0           10.0         3.0         3.0         14.8         20.0	NAM	<b>PLATE</b>		Æ	ASURE		FACTOR	EXIST	IMPR	SAVINGS	HRS/	SAVINGS
OVER 10.0 29.0 200 16.0  OVER 10.0 29.0 20.0 16.0  OVER 10.0 29.0 20.0 16.0  7.5 24.4 200 20.8 82.5%  5.0 15 200 82.5%  5.0 15 200 82.5%  1.0 3.0 20.8 82.5%  1.0 3.0 20.8 82.5%  5.0 15 200 82.5%  1.0 3.0 20.8 82.5%  5.0 14.4 200  1.0 3.0 20.0 20.0  5.0 3.0 11.4 200  1.0 3.0 20.0 20.0  5.0 3.0 11.4 20.0  1.0 3.0 20.0 20.0  5.0 3.0 11.4 20.0  1.0 3.0 20.0 20.0  5.0 3.0 11.4 20.0  5.0 14.8 200 0.855  5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200  1.0 5.0 14.8 200	FF	/OLTS	EFF	AMPS	PF	VOLTS	8	H	EFF	(KW)	YEAR	(kWh/yr)
OWER     30.0     85.0     200       OWER     10.0     29.0     20.8     16.0       OWER     10.0     29.0     20.8     82.5%     16.7       2.0     6.0     20.8     82.5%     16.7       2.0     6.0     20.8     82.5%     16.7       2.0     6     20.8     82.5%     16.7       5.0     15     20.8     82.5%       1.0     3.0     20.8     82.5%       1.0     3.0     20.8     82.5%       1.0     3.0     20.8     82.5%       5.0     11.4     20.0     9.6       5.0     11.4     20.0     9.6       5.0     11.4     20.0     9.6       5.0     11.4     20.0     9.6       5.0     14.8     20.0     0.855       1.0     14.2     20.8     14.2       1.0     14.2     20.8     14.2     20.8       1.0     14.2     20.8     14.2     20.8       1.0     14.2     20.8     14.2     20.8		88		9.06	0.84	203	85%	90.2%	93.6%	0.77	4380	3,355
OWER 10.0 29.0 208 82.5% 16.7   2.0 6.0 208 82.5% 16.7   2.0 6.0 208 82.5% 16.7   2.0 6.0 208 82.5% 16.7   2.0 6.0 208 82.5% 16.7   2.0 6.0 208 82.5% 16.7   2.0 6 208 82.5% 10.7   2.0 6 208 82.5% 10.7   2.0 7.5 24.4 200   3.0 11.4		8					85%	90.5%	93.6%	0.77		
OWER 10.0 29.0 208 82.5% 16.7 7.5 24.4 200 2.208 82.5% 5.0 15 208 82.5% 5.0 15 200 82.5% 1.0 3.8 200 1.0 3.0 208 1.0 208 1.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2		88		16.0	0.75	202	85%	87.5%	91.7%	0.33		1,454
2.0 6.0 208 82.5% 7.5 24.4 200 5.0 15 208 62.5% 2.0 6 208 82.5% 5.0 15 200 1.0 3.0 208 1.0 3.0 208 1.0 3.0 208 3.0 9.6 200 5.0 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 5.0 14.8 200 5.0 14.8 200 1.0 5.0 14.8 200 5.0 14.8 200		88		16.7	0.72	8	85%	87.5%	91.7%	0.33	_	1,454
7.5     24.4     200     62.5%       5.0     15     208     62.5%       5.0     15     208     82.5%       1.0     3.8     200     82.5%       1.0     3.0     208     82.5%       1.0     3.0     208     82.5%       1.0     3.0     208     82.5%       5.0     3.0     208     80       5.0     3.0     9.6     200       3.0     11.4     200     200       1.1     200     3.0     4.8       5.0     14.8     200     0.855       5.0     14.2     208       5.0     14.2     208       5.1     14.2     208       5.1     14.2     208       5.1     14.2     208			82.5%				85%	82.5%	86.5%	0.07	8760	623
5.0     15     208     62.5%       2.0     6     208     82.5%       5.0     15     200     82.5%       1.0     3.8     200     82.5%       1.0     3.0     208     82.5%       1.0     3.0     208     82.5%       1.0     3.0     208     82.5%       5.0     3.0     3.0     208       5.0     3.0     3.0     3.0       1.1     200     3.0     3.0       1.1     200     3.0     3.0       1.1     200     3.0     3.0       1.1     200     3.0     3.0       1.1     200     3.0     3.0       1.1     200     3.0     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       5.0     14.2     208     3.0       6.0     14.2     3.0     3.0       7.0     1		800					85%	86.5%	91.7%	0.31		2,731
2.0 6 208 82.5% 5.0 15 200 1.0 3.8 200 1.0 3.0 208 1.0 3.0 208 5.0 9.6 200 5.0 9.6 200 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 5.0 14.8 200			62.5%				85%	62.5%	89.5%		8760	13,406
5.0     15     200       1.0     3.8     200       1.0     3.0     208       1.0     3.0     208       5.0     20     9.6       5.0     3.0     20       5.0     3.0     20       5.0     3.0     11.4     20       3.0     11.4     20       3.0     14.8     20       5.0     14.8     20       5.0     14.8     20       5.0     14.2     20       5.0     14.2     20       5.0     14.2     20       5.0     14.2     20       5.0     14.2     20			82.5%				85%	82.5%	86.5%			623
1.0         3.8         200           1.0         3.0         208           1.0         3.0         208           5.0         3.0         208           5.0         3.0         208           5.0         3.0         200           3.0         11.4         200           3.0         11.4         200           3.0         14.8         200           5.0         14.8         200           5.0         14.8         200           5.0         14.2         208           5.0         14.2         208           5.0         14.2         208							85%	85.5%	89.5%	0.17		1,452
102.5 1.0 3.0 208 1.0 3.0 208 3.0 9.6 200 5.0 8.6 200 5.0 11.4 200 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 5.0 14.8 200		88					85%	77.0%	86.5%	0.09		396
1.0 3.0 208 1.0 3.0 208 3.0 9.6 200 5.0 5.0 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 5.0 14.8 200	5									4.4		25,493
1.0 3.0 208 3.0 9.6 200 9.6 5.0 5.0 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 3.0 11.4 200 5.0 14.8 200 5.0 14.8 200 5.0 14.2 208		88					85%	77.0%	86.5%	0.09	8760	792
2.0 3.0 5.0 5.0 13.0 1.4 2.0 3.0 1.5 3.0 1.4 2.0 3.0 1.4 2.0 3.0 1.4 2.0 3.0 1.4 2.0 3.0 1.4 2.0 3.0 1.4 2.0 3.0 1.4 3.0 3.0 1.4 3.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5		80%	-				85%	77.0%	86.5%	0.09	8760	792
3.0 9.6 200 9.6 5.0 5.0 3.0 11.4 200 3.0 11.5 8.0 230 230 3.0 14.8 200 3.0 5.0 14.8 200 3.0 5.0 14.8 200 3.0 5.0 14.8 200 3.0 5.0 14.8 200 3.0 5.0 14.8 200 3.0 3.0 5.0 14.8 200 3.0 3.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5	0									0.2		1,585
5.0 13.0 3.0 11.4 200 3.0 11.4 200 1.5 8.0 230 7.5 8.0 230 5.0 14.8 200 5.0 14.2 208 5.0 14.2 208		88		9.6	0.80	200	85%	84.0%	88.5%		8760	1,009
13.0 3.0 11.4 200 3.0 11.4 200 1.5 8.0 230 7.5 8.0 230 5.0 14.8 200 5.0 14.8 200 5.0 14.2 208 5 14.2 208	0						85%	85.5%		0.17	8760	1,452
11.4 200 11.4 200 8.0 230 9.6 200 14.8 200 14.2 208 14.2 208	0						85%	85.5%	89.5%	0.17	8760	1,452
11.4 200 11.4 200 8.0 230 9.6 200 14.8 200 14.2 208 14.2 208	0									0.4		3,912
11.4 200 8.0 230 9.6 200 14.8 200 14.2 208 14.2 208	0 11.4	8					<b>82</b> %	84.0%			8760	1,009
9.6 200 14.8 200 14.2 208 14.2 208	_	8					85%	84.0%	88.5%			1,009
9.6 200 14.8 200 14.2 208 14.2 208		230					85%	77.0%	86.5%		8760	1,188
9.6 200 14.8 200 14.2 208 14.2 208	2									0.4		3,206
14.8 200 14 208 14.2 208		8					85%	84.0%			8760	1,009
14.2		88	0.855				85%	85.5%	89.5%		8760	
14.2		88					85%	85.5%				1,452
Vol.		208					85%	85.5%	89.2%	0.17	8760	1,452
	0									9.0		5,364

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 15-Jul-92 EII E: ECO.-5 WK3

FILE: ECO--5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

_										2		_			
FOUIPMENT	NOTE	UNDER		NAM	EPLATE		Ξ	MEASURED	ŒD	<b>FACTOR</b>	EXIST	IMPRVD	SAVINGS	HRS/	SAVINGS
	] 	SIZED			VOLTS	EFF	AMPS	PF	VOLTS	(%)		EFF	<b>₹</b>	<u>~</u>	(kWh/yr)
			3.0	6	82					82%	L	88.5%			1,009
		OVER	15.0	49	200	0.875	27.7	0.81	508	85%	87.5%	92.4%			5,050
		i i	2.0	99	200					85%	80.0%	86.5%	0.12	8760	1,044
			2	14.4	230					85%	85.5%	89.5%			1,452
			7.5	2	230					85%		91.7%	0.31		2,731
			· C	14.4	230					85%	85.5%	89.5%			1,452
			, vc	144	330					85%		89.5%			1,452
			) <b>4</b>		230					85%					1,452
- 22			א כ	14.4	3 8					85%				8760	1,452
			ט ע	144	23.0					85%					1,452
			) V	14.4	230					85%					1,452
•			5	90	2 8	0.865				85%					1,821
			2 5	9 6	800	0.865		_		85%				4380	1,821
	-		20	2	2 8					85%					522
			1	3.75	88					85%		_			396
			7.5	2	230					85%			0.31	4380	1,366
<u></u> 5	#		7.5	2	230										,
COND PUMP 1		_,	က	6	8					82%					252
- C			3.0	6	200					85%	84.0%	88.5%		2190	252
TOTAL			106.5										3.9	لننا	26,425
			150	196	460		16	0.81	472	85%	88.5%	92.4%	0.45	4380	1,987
-		ATA C	40.0	49			25.9				_				8,044
		1100	55.0	2				١					1.4	L	9
			9 6	9	Ş					85%	84.0%	88.5%	0.12	8760	1,009
			0	69	33					82%		86.5%	0.12		
			i e	8	28					82%				2 8760	1,009
COND PLIMP 2			30	82	208					85%				8760	1,009
			110										0.5		4,070
CIDC EAN 1		000000000000000000000000000000000000000	30		88					85%	84.0%	88.5%		2 2190	252
- 0	<b>*</b>		30	8	8					85%					
	Ę		-		8	- A-H	2		506		87.5%				2,908
			, v	o o	2	0.84		<del></del>						3 8760	2,032
COND PINE 4			7.5	2,5	38					85%		91.7%			683
COND PLIMP 2			7.5	2	8					85%				2190	683
															6.557

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

			OVER/								OAD			DEMAND		ELECTRIC
BLDG.	BLDG. EQUIPMENT	NOTE	UNDER		NAN	NAMEPLATE		Ī	MEASURED		FACTOR EX	EXIST		SAVINGS		, .,
*	DESC		SIZED	프	٦		EFF	AMPS PF	PF	VOLTS	8	H.F.	FFF	(KW)		
512	AHC 1			5.0	14.8	4I					250/	AF 50			02/0	
	AHU 2			3.0	2 2	88					8 %	84.5	80.08 80.08 80.08		00/00	
	TOTAL			8.0							3	2		0.3	3	
735	AHU 1		OVER	10	8	8		23	23 0.76	ğ	85%	87.5%	91.7%	0.33	2190	727
	TOTAL			10.0										0.3		
932	HWP 1			5.0	12.8	230					85%	85.5%		0.17		726
·	-IMP 2			3.0	6	200					85%	84.0%				1.009
	를 구 			2.0		208					85%	80.0%				522
-	ATC 4			1.5	4.8	88					85%	77.0%	86.5%		8760	1.188
للحت.	AHU 5			5.0	14.7	802					85%	85.5%				726
Ţ	FOTAL			16.5											ı	1711

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECCO: 5 — Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 15-Jul-92	PILE: ECO-5.WK3 PREPARED BY: R. GERRANS CHECKED BY:
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		<u>ა</u>	COST	SUB					
BLDG.	EQUIPMENT	MOTOR LABOR	LABOR	_	OH&B	PROFIT	TOTAL	CONT	TOTAL
	DESC	€	<b>3</b>	- 1	15%	10%	Ø	15%	3
101	HWP 1	\$1,639	\$152	\$1,791	\$269	\$179	\$2,239	\$ 9238	\$2,575
	HWP 2							1	
	CWP 1	\$750	\$76	\$856	\$124	£83			\$1,188
	CWP 2	\$750	\$76	9Z8 <b>3</b>	\$124	\$83		••	\$1,188
	AHU1	\$329	89	\$427	\$64	\$43			\$614
	AHL 2	\$616	\$72	8898	\$103	69\$		•	\$300
	AHU 3	\$420	89	\$488	\$73	\$49			\$701
	AHI 1 FI R 4	\$359	899	\$427	\$64	\$43			\$614
	AHU 3 FLR 4	\$420	899	\$488	\$73	\$49	\$610	\$91	\$701
	AHI 4	\$292	898	\$360	\$54	\$36			\$517
	TOTAL						شنا		280'6\$
133	AHI 1	\$292		8360	\$5				\$517
	AHUS	\$292	898	8360	\$52	\$36	\$450	295	\$517
	TOTAL								\$1,035
103	AHU 1	\$366							\$624
	ROOF AHU 1	\$420						\$91	\$701
	ROOF AHU 2	\$420	89	\$488	\$73	\$49	\$610		\$701
	TOTAL								\$2,026
133	AHL 1	\$366					L		\$624
	AHILO	\$366						88	\$624
	AHU 3	\$328		\$396	\$29	\$40	\$495		
	TOTAL								
207	AHU 1	\$366							\$624
	AHU 2	\$420							\$701
	AHU 3	\$420				\$49	\$610	\$91	\$701
	AHO 4	\$420	89	\$488	\$73				\$701
	TOTAL								\$2,727

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GEHRANS
CHECKED BY:

		<del>-</del>		_	_		_						_	_	_			_		_	16	- 7	_	-	-	_	=	_	_		-	_	~	=	_	_
	TOTAL	2	\$624	\$1,580	\$614	\$701	066\$	\$701	\$701	\$701	\$701	\$701	\$701	\$1,188	\$1,188	\$614	\$517	999 1	7036	1700	470¢	414,408	\$1,580	\$3,443	\$5,023	\$624	\$614	\$624	\$624	\$2,484	\$624	\$624	\$1,18	\$701	2990	299
	CONT	2% C	88	\$206	88	\$91	\$129	\$91	\$91	\$91	\$91	\$91	\$91	\$155	\$155	280	29\$	\$129	Ğ	9 6	<u>န</u>		\$206	\$449		\$81	88	\$81	\$81		\$81	\$8	\$155	\$91	\$129	\$129
SUB	TOTAL	2	\$542	\$1,374	\$534	\$610	\$861	\$610	\$610	\$610	\$610	\$610	\$610	\$1,033	\$1,033	\$534	\$450	\$861	6.7	400	740		\$1,374	\$2,994		\$542	\$534	\$542	\$542		\$542	\$542	\$1,033	\$610	\$861	\$861
	PROFIT	<b>%</b>	\$43	\$110	\$43	\$49	69\$	\$49	\$49	\$49	\$49	\$49	\$49	\$83	\$83	\$43	\$36	69\$	6	2 5	24		\$110	\$239		\$43	\$43	\$43	\$43		\$43	\$43	\$83	\$49	69\$	869
	OH&B	12%	\$65	\$165	\$	\$73	\$103	\$73	\$73	\$73	\$73	\$73	\$73	\$124	\$124	\$64	\$54	\$103	206	0 t	C08		\$165	\$359		\$65	\$64	\$65	\$65		\$65	\$65	\$124	\$73	\$103	\$103
SUB	_	- 11									\$488					\$427	\$360	\$688	7076	5 6	*		\$1,099	\$2,395		\$434	\$427	\$434	\$434		\$434	\$434	\$826	\$488	\$688	8898
COST	ABOR	2	89	\$114	89	89	\$72	89	89	89	898	898	898	\$76	\$76	89\$	898	\$72	006	9 6	000		\$114	\$183		898	898	89\$	898		<b>\$68</b>	89\$	\$76	89	\$72	\$72
) )	MOTOR LABOR	(£)	\$366	\$985	\$328	\$420	\$616	\$420	\$420	\$420	\$420	\$420	\$420	\$750	\$750	\$329	\$292	\$616	3364	000	0000		\$982	\$2,212		\$366	\$329	\$366	\$366		\$366	\$366	\$750	\$420	\$616	\$616
	EQUIPMENT	DESC	된	H 28	FL 38	AHU 1	H22	HU3	HU 4	HU5	AHU 6	AHU 7	F18	CWP 1	CWP 2	CWP 3	+WP 3	IWP 1	HWP2		JUND FOINT A	OIAL OIAL	₽₩	ATC	TOTAL	15.1	AHU 2	~	COND. PUMP 2		١.	CIRC. FAN 2	_	HU2	COND. PUMP 1	COND. PUMP 2
	BLDG.	*		⋖.	⋖	⋖	.≰.	∡	.≪	≪	⋖	.≤.	⋖.	ں	ں	U			<u> </u>	<i>)</i> (		-	214	4		308 A		<u>U</u>	J		8	<u> </u>	4	_	<u>.                                    </u>	J

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

EMC PROJECT: #3105.000 DATE: 15-Jul-92

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

		5	3	SCB			SUB		
BLDG.	EQU	MOTOR	LABOR	TOTAL	OH&B	PROFIT 1	TOTAL	CONT	TOTAL
*	DESC	€	9	Ø	15%	10%	æ	1	
512	AHU 1	\$420	893	\$488 \$488	\$73	\$49	\$610		
	AHU 2	\$366	\$68	\$434	\$65	\$43	\$542		
	TOTAL								
735	AEC 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	
	TOTAL								
935	HWD 1	\$420	888	\$488	\$73	\$49			
	HWP 2	\$366	89	\$434	\$65	\$43			
	AHC 1	\$329	898	\$427	\$6	\$43			
	AHD 4	\$328	\$68	\$396	\$29	\$40	\$495	\$74	
	AHU 5	\$420	898	\$488	\$73	\$49			
	TOTAL								\$3,209

Denver • Colorado Springs • Atlanta • Germany

	MCPHERSON/GILLEM E EMC #3105.000	
	CEL	
CHECKED BY		_ DATE
SCALE		

### RESEARCH OF PREMIUM EFFICIENCY MOTORS WITH SPEED CONTROLS:

A number of good articles on energy efficient motors and motor controls were reviewed. A list of these articles is provided below.

In regards to the question of, "Should energy efficient motors be used with variable speed controls?", one article stated:

"When using adjustable-speed drives, it is best to specify the highest-efficiency motor possible. Inverters deliver a waveform that is less than an ideal pure sine wave. This chopped waveform causes more heating and losses in the motor. A motor with less losses can tolerate more impurities in input power without overheating. Heat is the ultimate enemy of motors, reducing life expectancy. For every 10oC higher running temperature, the life of the motor is cut in half. Premium-efficiency motors also run quieter and give a wider full-load speed range than normal motors operating on an adjustable-speed drive." *Energy Efficiency In Electric Motors*, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

In regards to the question of, "Is the improved efficiency due to the frequency of the motor or some other factors?", see is the attached article from General Electric, describing motor losses, construction of high-efficiency motors, and motor standards.

### **ARTICLES:**

How to Select, Apply, and Install, Modern Motors and Controllers, Robert Lawrie, EC&M, June 1991.

Variable-Frequency Drives Take Hold In HVAC Market, Paul Beck, Consulting/Specifying Engineer, September 1991.

Applying AC Adjustable Frequency Drives to HVAC Systems, Kenneth A. Fanstad, Consulting Specifying Engineer, May 1989.

Energy Efficiency In Electric Motors, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

### Motor Selection Based Only On Purchase Price Can Be A Costly Mistake

Energy efficient motors represent an investment of 20 to 25% over the cost of standard, normal efficiency motors. While this premium can be recovered in a short period of time, the first objective should be to maximize the return on investment. To reach this goal, the motor user needs to understand motor efficiency, how it is achieved and how to conduct an economic evaluation. It is vital to evaluate the differences between motors offered by various manufacturers and only choose motors which clearly meet the user's operating criteria and cost reduction goals.

### **Understanding Motor Losses**

Motor efficiency, as shown in Figure 1, is the watts output divided by the watts input. This is better expressed as the watts input minus the losses divided by the watts input.

Efficiency = 
$$\frac{746 \text{ x Hp Output}}{\text{Watts Input}}$$

$$= \frac{\text{Input - Losses}}{\text{Input}}$$

Figure 1. Efficiency Equation

The only way to improve efficiency is to reduce motor losses. The components of motor losses can be broadly defined as no-load losses and load losses as shown in Figure 2.

% Total	
14	
16	
33	
15	
22	
100	
	14 16 33 15 22

Figure 2. Distribution of Losses

No load losses account for 30% of the total losses and include windage and friction losses plus core losses. The windage and friction losses are mechanical losses from bearing friction plus fan and rotor windage. Core losses are a combination of hysteresis and eddy current losses in the magnetic steel core.

Load losses account for the remaining 70% of the total losses and include stator and rotor I²R losses and stray load losses. Stator losses are the product of stator input current (at load) squared and the stator resistance at operating temperature. Rotor losses result from rotor currents and are the product of the induced rotor current squared and the rotor resistance at operating temperature. Motor slip is a result of rotor losses.

Stray load losses are a result of additional harmonic and circulating current losses in the magnetic steel and windings. These losses are a result of design and manufacturing processes. Some of the factors which contribute to stray load losses are shown in Figure 3.

- Number of Slots
- Stator and Rotor Slot Geometry
- Rotor Slot Insulation
- Air Gap Length
- Manufacturing Process Control

Figure 3. Stray Load Loss Factors

### Improving Efficiency Takes Know-how

The energy efficient motor design engineer strives for design optimization using techniques shown in Figure 4.

Most motors available today use a low carbon lamination steel for rotor and stator construction. This steel typically has 3.0 watts-per-pound of electrical losses and costs approximately the same as cold rolled steel. To reduce hysteresis and eddy current losses, manufacturers build energy efficient motors with high grade silicon steel. This steel has an electrical loss of 1.5 watts-per-pound and costs approximately 50% more than standard motor lamination steel.

- Improved Steel Properties
- Thinner Laminations
- Increased Wire Volume
- Improved Slot Designs
- More Steel
- Improved Rotor Insulation System
- More Efficient Fan Design

Figure 4. Efficiency Improvement

To further reduce eddy current losses, the high grade silicon steel is purchased in a thinner gauge than the low carbon lamination steel. Typical lamination thickness is .018 and .022 inches for the silicon and low carbon steel, respectively. In addition, the silicon steel has a surface coat of insulation to provide high interlamination resistance to eddy currents.

By increasing the volume of copper wire by 35 to 40%, the stator I²R losses can be reduced. To accommodate this increase, slot areas must also be increased by as much as 50%. To compensate for the increase in slot size and corresponding decrease in active steel, the motor's rotor and stator core are lengthened. In addition to minimizing losses, this also reduces flux density and improves motor power factor. Nice additional benefits.

Rotor I<sup>2</sup>R losses are improved through redesign of the rotor slots to increase the conductor cross section. In doing so, the rotor full load speed is increased slightly. The slot redesign must be made in such a way to continue to provide NEMA design B torques and locked rotor currents. This requires careful selection of the slot shape as well as the slot size.

Some of the losses in the motor are due to unplanned conduction paths which result from normal manufacturing processes. One such path is along the rotor surface where the rotor OD is turned down to provide a uniform air gap. Careful choice and control of the process are required to keep losses at a minimum.

Another such path is the current flow between rotor bars where the rotor is skewed. Skewing is a normal practice in small motors to reduce noise and torque pulsations. To minimize losses from inter-bar currents, the raw punched edges of the rotor slots are treated with a high temperature inorganic insulation before casting.

Because of the lower electromagnetic losses in an energy efficient motor, the motor does not require the same cooling as a standard motor design. This allows the designer to use a smaller fan to reduce windage and friction losses while achieving quieter operation.

In summary, by optimizing the design, motor losses are decreased and efficiency improvements are gained. As market conditions dictate and materials and technologies improve, further efficiency gains will be achieved.

### Making The Standards Work For You

NEMA has adopted an efficiency labeling standard based upon probabilities (MG 1-12.54.2) which will help the buyer get what he is paying for. The bell-shaped curve shown in Figure 5, assumes that, once the nominal value of efficiency is defined for a specific motor design, half of the motors will be above that value and half below.

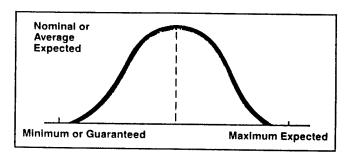


Figure 5. Motor Efficiency

The standard, which applies to NEMA designs A and B, single speed, polyphase, squirrel-cage, integral-Hp motors in the 1 through 125 horsepower sizes, calls for the nominal efficiency to be identified on the motor nameplate. This standard recognizes that variations in materials, manufacturing processes and test results cause motor to motor efficiency variations for a given design. Therefore, the full-load efficiency for a large population of motors of a given design is not a unique value but rather a band of efficiencies. The standard defines the minimum and nominal efficiency to expect from a motor design for a population of motors and

the manufacturer must select from the values in Figure 6. GE motors exceed these standards.

1				
Nominal Efficiency 98.0 97.8 97.6 97.4 97.1 96.8 96.5 96.2 95.8 95.4 95.0 94.5 94.1 93.6 93.0	Minimum Efficiency 97.6 97.4 97.1 96.8 96.5 96.2 95.8 95.4 95.0 94.5 94.1 93.6 93.0 92.4 91.7	Nominal Efficiency 87.5 86.5 85.5 84.0 82.5 81.5 80.0 78.5 77.0 75.5 74.0 72.0 70.0 68.0 66.0 64.0	Minimum Efficiency 85.5 84.0 82.5 81.5 80.0 78.5 77.0 75.5 74.0 72.0 70.0 68.0 66.0 64.0 62.0 59.5	
96.5	95.8	80.0	77.0	
			74.0	
		75.5	72.0	
		74.0	70.0	
94.5	93.6	72.0	68.0	
94.1	93.0	70.0	66.0	
93.6	92.4	68.0	64.0	
93.0	91.7	66.0	62.0	
92.4	91.0	64.0		
91.7	90.2	62.0	57.5	
91.0	89.5	59.5	55.0	
90.2	88.5	57.5	52.5	
89.5	87.5	55.0	50.5	
88.5	86.5	52.5	48.0	
		50.5	46.0	

gure 6. NEMA Efficiency Marking Standard

This standard establishes the nominal efficiency values that are to be used on the motor nameplate, the motor manufacturer selects the value range for a given design from the table.

NEMA standard MG 1-12.55 specifies efficiency levels for polyphase squirrel-cage induction motors to be classified as energy efficient. The nominal full-load efficiency as determined in accordance with MG 1-12.54.1 (IEEE test procedure 112, method B) and identified on the nameplate in accordance to the labeling standard MG 1-12.54.2, must equal or exceed the values shown in appendix "A" for the motor to be classified as energy efficient.

### Specifying Guaranteed Values Is Best

Buyers who only specify the nominal efficiency value for new energy efficient motor purchases are relying on the manufacturer to consistently provide motors within the band defined in the NEMA standards. By specifying and evaluating motors at the guaranteed minimum efficiency, the buyer can feel confident that his economic evaluation is conservative but reasonable. The buyer also has a basis to reject any motor which does not meet the guarantee.

The motor user who specifies and evaluates on guaranteed minimum efficiency values will discourage casual efficiency claims and can select a motor supplier with confidence.

### The Energy Efficient Motor Decision

Specification and installation of energy efficient motors can yield attractive economic results compared to standard efficiency designs for the same installation.

To fully understand these benefits, the buyer can make either a simple payback calculation or a comprehensive economic evaluation including a life cycle cost analysis. Typically, as the quantity of motors increases and the value of the installation grows, a more detailed analysis is performed.

### How To Calculate Annual Savings

In comparing the efficiencies of two motors, the buyer must consider the type of motors involved, the annual hours of operation, motor load, electrical costs and the motor efficiencies. These basic data apply whether the comparison is between a standard and an energy efficient design or between two energy efficient designs with different efficiencies. Regardless of the comparison, it is essential that the efficiency values be on the same basis — you must compare nominal vs. nominal or guaranteed vs. guaranteed.

With that in mind, the equation in Figure 7 can be used to determine annual savings for two 50 horsepower, 1800 rpm, totally-enclosed, fancooled, severe-duty motors operating at rated load. The nominal efficiency value for the standard efficiency motor is 91.7 while the comparable value for the energy efficient motor is 94.1. If operated continuously (8760 hours) with an electrical cost of \$.0512/kWh, the annual savings would be \$465.

# INSTALL HIGH EFFICIENCY MOTORS

MOTORS OPERA	RATING AT	TING AT FULL LOAD	DEMAN	DEMAND COST:	DEMAND COST: \$8.85/kW			
<u>8</u>	(1800 RPM)		HOURS	S OF OPERA	TION PER YEAR			
			2000 HRS		4000 HRS		8760 HRS	
	PREMIUM	DIFFERENTIAL COST *	SAVINGS/	SIMPLE	SAVINGS/ YEAR	SIMPLE	SAVINGS/ YFAB	SIMPLE
	86.5%	\$148	\$14	10.6		8.0		5.0
	86.5%	\$167	\$21	8.0	\$28	6.0	\$44	3.8
	86.5%	\$178	\$18	9.7	\$24	7.3	\$39	4.6
İ	88.5%	\$172	\$18	9.7	\$24	7.3	\$38	4.6
	89.5%	\$201	\$25	7.9	\$34	5.9	\$54	3.7
	91.7%	\$305	\$48	6.4	\$64	4.8	\$102	3.0
	91.7%	\$370	\$51	7.3	89\$	5.4	\$108	3.4
	92.4%	\$495	\$70	7.1	\$93	5.3	\$148	3.3
1	93.0%	\$579	\$65	8.9	283	6.7	\$138	4.2
	93.6%	\$646	86\$	9.9	\$131	4.9	\$208	3.1
ı	94.1%	\$729	\$134	5.4	\$179	4.1	\$285	2.6
- 1	94.1%	\$1,042	\$141	7.4	\$188	5.5	\$299	3.5
i	94.5%	\$1,214	\$157	7.7	\$210	5.8	\$334	3.6
1	94.5%	\$1,515	\$189	8.0	\$252	0.9	\$401	3.8
1	94.5%	\$1,743	\$193	0.6	\$257	6.8	\$409	4.3
	94.6%	\$2,666	2177	15.0	\$236	11.3	\$376	7.1

\* DIFFERENTIAL COST DOES NOT INCLUDE LABOR COSTS

### APPENDIX C-6 ADD ECONOMIZERS

PROJECT: FORT McPHERSON & FORT ĞILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: ECONOMIZERS

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**EMC PROJECT:** 

07/17/92 ECONOG.WK3 DENNIS JONES #3105.000

> PRPARED BY: CHECKED BY: DATE: FILE:

				ł		_			
						SE		0.4	
					CONST.	COST	(\$)	39,924	
				TOTAL		SAVINGS	( <del>Q</del> )	3962	
				ANNOAL	NON-ENE	SAVINGS	(%)	0	
			:	ANNOAL	DEMAND	SAVINGS	<b>(%)</b>	0	
Ç	19.64 UPWG 15.23 UPWE	UPW		ANNOAL	ENERGY	SAVINGS	<b>(</b>	965	
PACTOR	19.64 15.23	14.68 UPW		TOTAL	ENERGY	SAVINGS	(MBtn)	123	
	MBtu KWh	ΚW	YRS	łl.	NAT GAS		(MBtr.)	0	
ENERGY COST	\$0.0255	\$102.66	15 \	ANNUAL ANNUAL	DEMAND ELECTRIC	SAVINGS	(KWH)	37,833	
	JST AIC COST	ARGE		ANNOAL	DEMAND	SAVINGS	SS S	0	
	INCREMENTAL GAS COST INCREMENTAL FLECTRIC COST	ELECTRIC DEMAND CHARGE	ECONOMIC LIFE		BUILDING	NUMBER		101	

SIMPLE PAYBACK (YRS)

41.4

COST ESTIMATE ANALYSIS	ANAL	YSIS				NVITATION NO.	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	a
						DACA 21-91-C-0097	1-C-0097			DATE APR 92	2	-Ap	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	S Study					X CODE A	CODEB	CODEC		DRAWING NO.	Ċ.	SHT OF	
LOCATION Ft. McPherson & Ft Gillem						Fig. 10				ESTIMATOR PMG	PMG	CHECKED BY CEL	田田
	Ous	Quantity		LABOR	œ		EQUIPMENT	ENT	MATERIAL	JAN.	TOTAL	SHIPPING	ပ
ECO 6 - Economizers	5	S.	Ĭ	Total	Ç		Cnit		Unit			, E	Total
TASK DESCRIPTION	Units	Meas	Cuit	T	Price	Cost	Price	Cost	Price			*	₹
OPPOSED BLADE DAMPERS (2)	-	MCFM	-	-	\$21.17	\$21.17			\$80.00		\$101.17		
LOUVERS, GALVANIZED	-	MCFM	1	1	\$21.17	\$21.17			\$58.00				
DAMPER OPERATOR, B. ECTRIC	2	ā	1.33	2.66	\$20.88	\$55.54			\$150.00		- 1		
OTS	6		2	9	\$21.17	\$127.02			\$160.00	\$480.00	\$607.02		
STS	2		1.5	က	\$21.17	\$63.51			\$118.00	\$236.00	\$299.51		
PEOGRAMMING	7	-			\$150.00	\$1,050.00					\$1,050.00		
WIRE & CONDUIT	7	+							ጷ	\$658.00	\$658.00		
CONTROLLER	-	-							1,100	\$1,100.00	\$1,100.00		
SUBET METAL MODIEICATION	\	+	80	8	\$20.88	\$167.04					\$167.04		
-6													
2													
								ļ					
						\$1 505 45				\$2,912.00	\$4,417.45		
	1594					\$225.82				\$436.80	\$662.62		
DOCET CALL BOXED	45	9 3				\$150.55				\$291.20	\$441.75		
SOUTH TOTAL						181.881.81				\$3,640.00	\$5,521.81		
COST SUB-TOTAL	459					12 0802				\$546.00	\$828.27		
CONTINGENCY	2					eo 164 00				\$4,186.00	86,350.09		
<b>V</b>						- 171.22							

	777	<b>VS:IV</b>			=	INVITATION NO./CONTRACT NO	CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	Ü
				_		DACA 21-91-C-0097	-C-0097			DATE APR 92	22	4	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	Study					X CODE A	CODEB	CODEC		DRAWING NO.	O.	SHT OF	
LOCATION Ft. McPherson & Ft Gillem						מושבוס				ESTIMATOR RMG	RMG	CHECKED BY CE.	点
	Quantity	ntity		LABOR	6		EQUIPMENT	ENT	MATERIAL	JAIL.	TOTAL	SHIPPING	g
ECO-6, ECONOMIZERS $BLDG 101$	<b>№</b> .0	Chit	ΞĘ	Total	Cair	_	Unit		Unit			֓֞֞֞֞֓֓֓֞֞֓֓֟֟֓֓֓֓֟֓֓֟֟֓֓֟֟֓֓֓֟֟֓֓֓֟֟֓	Total
TASK DESCRIPTION	Units	Meas	Unit	Hrs	Price	Cost	Price	Sost	Price	Cost		<b>1</b>	-
4TH FLOOR AHUS 1 - 3											1		
OPPOSED BLADE DAMPERS (2)	52	25 MCFM	-	24.5	\$20.88	\$511.56			\$80.00		-		
LOUVERS, GALVANIZED	52	25 MCFM	-	24.5	\$20.88	\$511.56			\$58.00	49			Ì
DAMPER OPERATOR H FCTRIC	9	Æ	1.33	7.98	\$20.88	\$166.62			\$150.00				İ
OTC .	6	┿	2	18	\$20.88	\$375.84			\$160.00	49	₩.		
SIS	9	i	1.5	6	\$20.88	\$187.92			\$118.00	\$708.00			- 1
CINTERNO	7				\$150.00	\$3,150.00					\$3,150.00		
	6	_							2	\$1,974.00	\$1,974.00		
WINE & CONDOIL	j	+-							1,100		\$1,100.00		
CONTROLLER	- !		8,5	30 07	00 00	04 CCC 049			-		47		
		_											
		-											1_
						644 ONE OO		-		\$9.983.00	\$9,983.00 \$24,908.90		-
SUBTOTAL	1					C 226,F16				\$1,497.45	5 \$3,736.34		
OVEHHEAD, BOND	80	R >				C CON 13	-			\$998.30	52,490.89		
PROFIT	85	R				61 P 657 39				\$12,478.75	\$12,478.75 \$31,136.13		
COST SUB-TOTAL		<u> </u>	-			50 90K C4				\$1,871.81	1 \$4,670.42	0.	
CONTINGENCY	15%	<b>%</b>				\$K'/38.01				\$14.350.56			
			_		_	\$21.455.98	_	_	_				-

### APPENDIX C-7 CONTROL HOT WATER CIRCULATION PUMPS

LIFE CYCLE COS ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DAC FISCAL YEAR 1992 DISC ANALYSIS DATE: 07-17-92	A21-91-C-UU9/ RETE PORTION	NAME:	NERGI SAV : ECO-7 H	W PUMP CONT	ROL	015 062 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	Tr.	c – 11	D)		\$ \$ -\$	9868. 543. 592. 0. 11003.
<ol> <li>ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL</li> </ol>	COST (-) SAVINGS, UNI	IT CO	ST & DISC	COUNTED SAVI	NGS	
UNIT COST	SAVINGS MBTU/YR(2)	ANN SAV	UAL \$ INGS(3)	DISCOUNT FACTOR (4)	DIS SAV	COUNTED INGS (5)
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00 F. TOTAL	425. 0. 0. 233.	\$ \$ \$ \$	3176. 0. 0. 1088. 0.	11.11 14.26 16.89 14.45 11.21		35290. 0. 0. 15723. 0.
F. TOTAL	658.	\$	4265.		\$	51013.
3. NON ENERGY SAVINGS(+)	/ COST(-)					
A. ANNUAL RECURRING	(+/-)			10 E0	\$	0.
A. ANNUAL RECURRING (1) DISCOUNT FACT	OR (TABLE A) AVING/COST (3)	ахз	A1)	10.59	\$	0.
C. TOTAL NON ENERGY I	DISCOUNTED SA	VINGS	(+)/COST	(-)(3A2+3Bd4	1)\$	0.
D. PROJECT NON ENERGY (1) 25% MAX NON I A IF 3D1 IS B IF 3D1 IS	. OIINT TETCATT	ON TE 2F5 X O TO SIR	ST (.33) ITEM 4 = (2F5+3	\$ 1683 D1)/1E)	34.	
4. FIRST YEAR DOLLAR SA	VINGS 2F3+3A+	(3B1D	/(YRS EC	ONOMIC LIFE	))\$	4265.
5. TOTAL NET DISCOUNTED	SAVINGS (2F5	+3C)			\$	51013.
6. DISCOUNTED SAVINGS R (IF < 1 PROJECT DOE:	S NOT QUALIFY	:)				
7. SIMPLE PAYBACK PERIO	D (ESTIMATED)		SPB=1E/4	2.	58	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 7 - Hot Water Pumps

FILE: ECO-7.WK3 PREPARED BY: R. GERRANS

CHECKED BY:

EMC PROJECT: #3105.000

16-Jul-92

DATE:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / KW	10.59 UPW
Connect ifor 4E vino		

Economic Life: 15 yrs

	SIMPLE PAYBACK (yrs)	2.6
	SIR	4.6
	CONST COST (\$)	\$11,003
	TOTAL ANNUAL SAVINGS (\$/yr)	\$4,264
ANNOAL	NON- ENERGY SAVINGS (\$/yr)	\$0
	ANNUAL DEMAND SAVINGS (\$/vr)	\$0
	FAL ANNUAL ANNUAL RGY ENERGY DEMAND NGS SAVINGS SAVINGS U/Vr) (\$/vr)	\$4,264
	TOTAL ENERGY SAVINGS (MBtu/yr)	658
	ANNUAL ANNUAL TOTAL ELECTRIC GAS ENERGY SAVINGS SAVINGS SAVINGS (KWh/vr) (MBtu/vr)	233
	PEAK ANNUAL ANNUAL TOT DEMAND ELECTRIC GAS ENER SAVINGS SAVINGS SAVINGS SAVINGS (kW) (kWh/vr) (MBtu/vr) (MBtu/vr) (MBtu/vr) (MBtu/vr)	124,564
	BLDG # DEMAND ELECTRIC GAS SAVINGS SAVINGS SAVING (kW) (kWh/vr) (MBtu/v	0
	BLDG #	101

rson & Ft. Gillem ESOS Stuc								-				
ESOS Str.			_		DACA 59-90-C-0087	3-C-0087		_	DATE APR. 91		P	
					CODEA	X CODE B	CODEC		DRAWING NO.		SHT OF	
					OTHER				ESTIMATORCE	过	CHECKED BY CE	日
		-	000			FOUPMENT	N.	MATERIAL	₫	TOTAL	SHIPPING	G
	No. Of Unit	ΉΣ	Total	rie C		Chit		Chit	i		Unit	Total
ASK DESCHIPTION			F	Price	Cost	Price	Cost	Price	Cost		¥	¥
		, u	0	24 47	¢211.70			261.0	522.00	734		
WTS	₹ i	0.0	2 4	2 2	£31.76			118	118.00	150		
STS	_	C: 0	0.	2 17	642.34			370	370.00	412		
VALVE		0,0	0 0	21.17	540 34			8	99.99	108		
ST/SP	<b>5</b> 5	0.4	2.5	21 17	\$52.93			52	129.00	182		
PUMP DPS	5	S,	3									
								60400	\$564.00	\$564 00		
WIRE AND CONDUIT	9							37.5	3			
PENGBAMMING	9				\$900.00					8800.00		
				_								
												ļ
					ě				\$1.789	\$3,050		
SUBTOTAL	-	-			18,18		-		\$265	<b>24</b>	-	
OVERHEAD, BOND	15%				816				\$177		-	
PROFIT	\$	-			183				\$2,211	69		
COST SUB-TOTAL					100,14				2522	\$572	6.	
CONTINGENCY	15%				04X				\$1.100	G		
CONTROLLER					-							
									\$3.643	\$5.484		
TOTAL THIS SHEET					\$1,842	6:			25			

### APPENDIX C-8 INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ANALYSIS SUMMARY  ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)  INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENS PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPP FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-8 WATER FLO ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED	** 1000	LICTOIG
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ \$ \$ -\$	830. 46. 50. 0. 926.
2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED S		
UNIT COST SAVINGS ANNUAL \$ DISCOUN FUEL \$/MBTU(1) MBTU/YR(2) SAVINGS(3) FACTOR(	T D	ISCOUNTED AVINGS (5)
A. ELECT \$ 7.47	.1  6  9  5	0. 0. 0. 6681.
F. TOTAL 99. \$ 462.	\$	6681.
3. NON ENERGY SAVINGS(+) / COST(-)		
A. ANNUAL RECURRING (+/-) (1) DISCOUNT FACTOR (TABLE A) (2) DISCOUNTED SAVING/COST (3A X 3A1)	<b>\$</b> 39	550.
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	5825.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3	Bd4)\$	5825.
D. PROJECT NON ENERGY QUALIFICATION TEST  (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$  A IF 3D1 IS = OR > 3C GO TO ITEM 4  B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)  C IF 3D1B IS = > 1 GO TO ITEM 4  D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	9.60	
4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LI		
J. 1011111 1121 2200011 2001 2001 1		12505.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= (IF < 1 PROJECT DOES NOT QUALIFY)	13.51	

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .91

### WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8 BUILDING 60

### Given:

# of people = 48 people -from field survey

Water heater efficiency = 70% -assumed

Gas cost = \$4.67 / MBtu -from utility rate analysis
Water Cost = \$2.39 / 1000 gals -from utility rate analysis

Showers:

# of showers = 18 showers -from field survey
Existing water flow = 3.75 gpm -from field survey
Improved water flow = 1.6 gpm -from field survey

Usage = (7 min/person day)\*(365 days/year)

= 2,555 min/person yr -assumed Shower water temperature  $= 102^{\circ}\text{F}$  -assumed

Supply water temperature = 66°F -from City of Atlanta info

Faucets:

# of faucets = 36 faucets -from field survey
Existing water flow = 2.25 gpm -from field survey
Improved water flow = 0.40 gpm -from field survey

Usage = (5 min/person day)\*(365 days/year) = 1,825 min/person yr -assumed

Faucet water temperature  $= 80^{\circ}F$  -assumed

Supply water temperature  $= 66^{\circ}F$  -from City of Atlanta info

### **Annual Existing Flow:**

Showers:

 $(48 \text{ people})^*(3.75 \text{ gpm})^*(2,555 \text{ min/yr}) = 459,900 \text{ gal/yr}$ 

Faucets:

 $(48 \text{ people})^*(2.25 \text{ gpm})^*(1,825 \text{ min/yr}) = 197,100 \text{ gal/yr}$ 

Total:

459,900 gal/yr + 197,100 gal/yr = 657,000 gal/yr

### Annual Improved Flow:

Showers:

 $(48 \text{ people})^*(1.6 \text{ gpm})^*(2,555 \text{ min/yr}) = 196,224 \text{ gal/yr}$ 

Faucets:

(48 people)\*(0.40 gpm)\*(1,825 min/yr) = 35,040 gal/yr

Total:

196,224 gal/yr + 35,040 gal/yr = 231,264 gal/yr

### Annual Non-Energy Savings:

Showers:

459,900 gal/yr - 196,224 gal/yr = 263,676 gal/yr

Faucets:

197,100 gal/yr - 35,040 gal/yr = 162,060 gal/yr

Total:

657,000 gal/yr - 231,264 gal/yr = 425,736 gal/yr

### Annual Energy Savings:

Showers:

(263,676 gal/yr)\*(8.33 lbs/gal)\*(1 Btu/lb °F)\*(102°F - 66°F)/70% = 113.0 MBtu/yr

Faucets:

(162,060 gal/yr)\*(8.33 lbs/gal)\*(1 Btu/lb °F)\*(80°F - 66°F)/70% = 27.0 MBtu/yr

Total:

113 MBtu/yr + 27 MBtu/yr = 140 MBtu/yr

### **Annual Cost Savings**

(\$4.67/MBtu)\*(140 MBtu/yr) + (\$2.39/1000 gal)\*(425,736 gal/yr) = \$1,671/yr

### **Estimated Construction Cost:**

\$31.74/shower

-from engineer's cost estimate

\$17.36/faucet

-from engineer's cost estimate

(\$31.74/ea)\*(18 showers) + (\$17.36/ea)\*(36 faucets) = \$1,196

\$1,196 + (\$1,196 \* .055 SIOH) + (\$1,196 \* .06 DESIGN) = \$1,334

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 8 - Water Flow Restrictors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

UDY EMC PROJECT: #3105.000
DATE: 15—Jul-92
FILE: ECO-8.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / KWh	11.11 UPWE
Demand Savings	\$8.85 / KW	10.59 UPW
Water Savings	\$2.910 / 1000 gals	10.59 UPW
conomic Life: 15 vrs		

ANNUAL DEMAND         NON— TOTAL DEMAND         TOTAL CONST SAVINGS SAVINGS COST (\$/yr)         COST (\$/yr)         \$/yr)         \$/xr								ANNUAL				
GAS         ENERGY         ENERGY         ENERGY         ENERGY         ENERGY         CONST         SAVINGS         SAVINGS         SAVINGS         SAVINGS         COST           SAVINGS         SAVINGS         SAVINGS         COST         (\$/yr)		PEAK	ANNUAL	MAL	TOTAL		ANNOAL	-NON	TOTAL		-	
SAVINGS SAVINGS SAVINGS SAVINGS COST           (MBtu/yr) (MBtu/yr)         (\$/yr)         (\$/yr)	BLDG #	DEMAND	ELECTRIC	GAS	ENERGY		DEMAND	ENERGY	ANNUAL	CONST	SIR	SIMPLE
(kW)         (kWh/yr)         (MBtu/yr)         (MBtu/yr)         (S/yr)         (		SAVINGS	SAVINGS	SAVINGS	SAVINGS		SAVINGS	SAVINGS	SAVINGS	COST		<b>PAYBACK</b>
0         0         99         \$460         \$0         \$550         \$1,010         \$425           00 cost for administation of small contract         0         99         \$460         \$0         \$550         \$1,010         \$925		<b>8</b>	(KWh/vr)		(MBtu/yr)		(\$/yr)	(\$/yr)	(\$/yr)			(yrs)
all contract \$500 99 99 \$460 \$0 \$550 \$1,010 \$925	<b>G93</b> 5		0	66			0\$	\$250	\$1,010		29.4	1 1
999 \$460 \$0 \$550 \$1,010 \$925	Include \$5	00 cost for a	dministation o	둚	act							
	TOTAL	0	0	66		\$460	<b>8</b>	\$550	\$1,010	\$925	13.5	Ö

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ESTRICTORS ECO: 8 - WATER FLOW RESTRICTORS

EMC PROJECT: #3105.000
DATE: 22-APR-92
FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS: WATER \$2.910 / 1000 gals

	WATER TEMP # USAGE	SHOWER SUPPLY FAUCETS / YEAR	(PF) (PF) (min/yr)		102   201	
	MPRVD W		5	7 7	114,975	
SHOWER FLOW RESIDENCIONS	FXIST		(Jajar)	7	344,925	
SHOWER FL	CVADAN	NO III	(maa)	, in 123	25.	
••	EVICT				4.50	
	110ACE	VEAD		(IIIIII)	2555	
	77	***************************************	CLIMOLIC		12	
	***	# C L C	PEOPLE	-	8	3
		֓֞֟֜֟֟֓֟֝֟֟֟֝֟֟ ֓֓֓֓֓֓֓֓֓֓֓֞֓֞֓֓֓֞֓֓֓֞֓֞֓֓֓֞֓֡֓֓֞֩֞֡֓֓֓֡			2	3

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECOALION: FOR GILLEM
ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

PREPARED BY: CHRIS STANLEY CHECKED BY:

EMC PROJECT: #3105.000

DATE: 22-APR-92

FILE: ECO8.WK3

COST SAVINGS:

WATER \$2.910 / 1000 gals

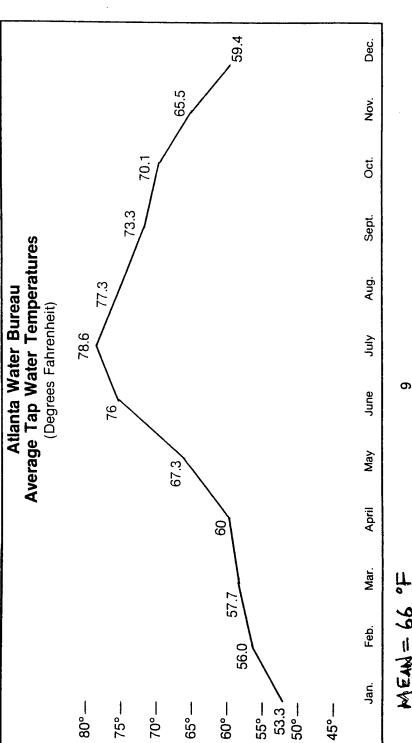
\$381 TOTAL COST 9 \$17.36 SHOWER FAUCET COST (\$/ea) COST \$31.74 COST (**\$**/ea) \$550 WATER SAVED (\$/XL) 98.5 229,950 WATER (gal/yr) SAVED (MBtu/yr) GAS SAVED SAVINGS HEATER %02 WATER EFF SUPPLY (°F) **WATER TEMP** FAUCET IMPRVD FAUCET FLOW RESTRICTORS FLOW (gal/yr) EXIST FLOW (gal/yr) IMPRVD FLOW (mdB) EXIST FLOW (mdb)

C-8	•	6

A STAMITON TOO	>   Y	0				NOTATIVA	INVITATION NO /CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	Ω
COSI ESTIMATE AIMETOR		2				DACA 21 -	DACA 21-91-C-0097			DATE APR 92	2	-Ap	
PROJECT F. McPherson & Ft. Gillem ESOS Study	λþ					X CODEA	CODEB	CODEC		DPAWING NO.	Ċ.	SHT OF	
7						OTHER				ESTIMATOR PMG	PMG	CHECKED BY	
		1		A POR A	ď		EQUIPMENT	EN	MATERIAL	IM.	TOTAL	SHIPPING	g
COO B - Water Flow Bestrictors	No. Of	Chit	MH	Total	Cait		Cait		Cait	1		E di	Total
	Units	Meas	Ę.	된		Cost	Price	Cost	Price	Sost Season	\$22.08		
I OW FLOW SHOWER HEAD	-	ā	0.330	0.330	\$21.45	\$7.08			300	300	80.00		
SUBTOTAL						\$7.08					\$3.31		
OVERHEAD, BOND	15%					\$1.00					\$2.21		
PROFIT	10%					7.03 40.04					\$27.60		
COST SUB-TOTAL						8 2					\$4.14		
CONTINGENCY	15%					\$10.18					\$31.74		
TOTAL						9							
	,	i	800	0.53	62145	\$7.08			\$5.00	\$5.00	\$1208		
LOW FLOW FAUCET		ă	0.55	0.00							\$1208		
SUBTOTAL						3.5					\$1.81		
OVERHEAD, BOND	15%					3 5					\$1.21		
PROFIT	10%					200					\$15.10		
COST SUB-TOTAL						3 2					\$2.36		
CONTINGENCY	15%					81018					\$17.36	9	
TOTAL.													
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Denver • Colorado Springs • Atlanta • Germany

3105.000 / ESOS SHEET NO CEL DATE 4/21/92 CALCULATED BY \_\_\_\_ CHECKED BY



### APPENDIX C-9

### HEAT RECLAIM FOR HOT REFRIGERANT GAS

The calculation performed on buildings 500 at Ft. McPherson indicated there were not adequate savings to justify the installation of desuperheaters. Building 500 was a best case analysis. Therefore no additional analysis was performed on other buildings.

The calculations for building 500 are attached for information.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: HEAT RECLAIM FROM HOT REFRIGERANT GAS

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE:

ij

HOTGAS.WK3 DENNIS JONES 07/17/92 #3105.000

PRPARED BY: CHECKED BY:

		ENERGY		DISCOUNT				
<del></del>		COST		FACTOR				
INCREMENTAL GAS COST		\$4.67	MBtu	14.45	UPWG			
INCREMENTAL ELECTRIC COST	<u>ठ</u>	\$0.0256 KWh	₩	11.11	11.11 UPWE			
ELECTING DEMAND CHARGE	ш	\$102.66 kW	N.	10.59 UPW	UPW			
		15	15 YRS					
ANK	MAL	ANNUAL ANNUAL ANNUAL	ANNUAL	TOTAL	ANNOAL	ANNUAL	ANNUAL ANNUAL TOTAL	TOTAL
BUILDING FLOOR DEM	SEMAND	ELECTRIC	NAT GAS	_	ENERGY	DEMAND	DEMAND NON-ENE	ANNOAL
	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS
_				. !	•	•	•	•

	ANNOAL	ANNUAL	ANNOAL	TOTAL	ANNOAL	ANNOAL	ANNUAL	TOTAL			
DING FLOOR	DEMAND	ELECTRIC	NAT GAS	ENERGY	ENERGY	DEMAND	NON-ENE	ANNOAL	CONST.		SIMPLE
AREA	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS		SAVINGS	COST	SIR	PAYBACK
	8	EXE EXE	(MBtu)	(MBtr)	9	<b>(%)</b>	<del>(</del> 8)	9	(%)		(XRS)
	0	0	158	158	738	0	0	738	16,579	9.0	22.5

Denver • Colorado Springs • Atlanta • Germany

JOB <u>Ft. McPherson</u> / Ft.	Gillem ESOS Study
SHEET NO. EMC # 3105.000	OF
CALCULATED BY	DATE
CHECKED BY	DATE
SCALE	

### BLDG. 500

### Assume

- 1) 7.5 ton chiller on 10' \* 10' walk in cooler
- 2) Assume 50% operation \* 2 chillers = 7.5 tons.
- 3) Desuperheaters will produce 2600 Btuh/ton in heating water from 75 °F to 140 °F.

For one day, hot water produced is:

2 \* 0.50 \* 7.5 tons \* 2600 Btu lbm °F gal \* 24 hrs = 867 gallons available heat (140 - 75) °F hr ton Btu \* 8.3 lbm

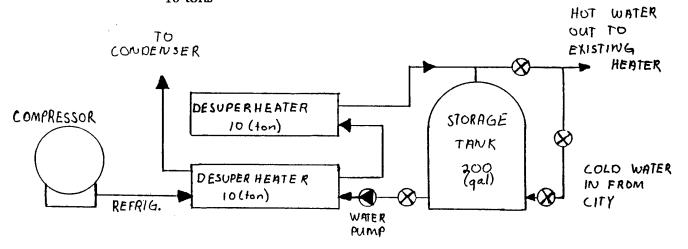
Resturants use 2.4 gallons per meal (ASHRAE HVAC 1991 44.10).

250 meals / day \* 2.4 gal / meal = 600 gallons HW Demand Heat reclaimed overnight must be stored, use 50%, 300 gallons storage capacity.

Maximum heat production:

For 10 ton unit, 75 °F - 140 °F heat gain: 10 ton \* 2,600 Btuh = 0.8 gpm 500 \* 52 °F

7.5 tons \* 2 chillers \* .8 gpm = 1.2 gpm pump size
10 tons



Gas saved = 600 gal \* (140 - 75) °F \* 8.3 lbs \* Btu \* 365 days \* MBtu = 157.75 MBtu / yr °F \* gal \* .75 \* yr \* 1,000,000 Btu

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SHEET NO	OF
CALCULATED BY	DATE
CHECKED BY	DATE
SCALE	

CHILLER FLUID HEAT FLUID SIZE FLOW PROD. FLOW	HEAT PROD.
SIZE FLOW PROD. FLOW (tons) (gpm) (Btuh) (gpm)	(Btuh)
10       0.8       26,000       1.9         20       1.6       52,000       3.8         30       2.4       78,000       5.7         40       3.2       104,000       7.6         50       4.0       130,000       9.5         60       4.8       156,000       11.4         70       5.6       182,000       13.3         80       6.4       208,000       15.2         90       7.2       134,000       17.1         100       8.0       160,000       19.0	23,750 47,500 71,250 95,000 118,750 142,500 166,250 190,000 213,750 237,500

<sup>-</sup> from manufacturer's literature

### E M C ENGINEERS, INC. Denver • Colorado Springs • Atlanta • Germany

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EMC # 3105.000	
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SCALE	

### ECO-9 HEAT RECLAIM FROM HOT REFRIGERANT GAS

A heat exchanger called a desuperheater will produce about MBtu of heat per ton of cooling. The desuperheater will provide hot water up to about 100 °F. Successful ECM requires significant DHW load to use the heat. Trane Co. provided the following costs for desuperheaters and refrigerant piping with installation costs included. Water side piping is not included.

<u>TONS</u>	<u>COST</u>
10	\$2000
20	\$2800
30	\$3700
40	\$5000
50	\$6000
60	\$7500
80	\$9800
100	\$12,200
120	\$15,500
160	\$20,000
200	\$23,000

TAG \_

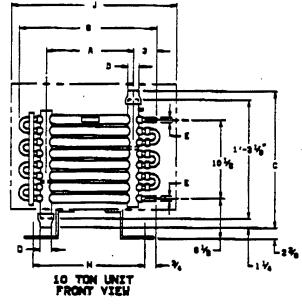
DATE PL-SV-CG-RDHA-SU-001.01 REPLACES: RDHA-SU-001.00 RDHA-SU-001.01

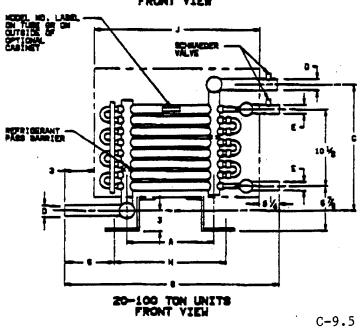
TRANE SUBMITTAL

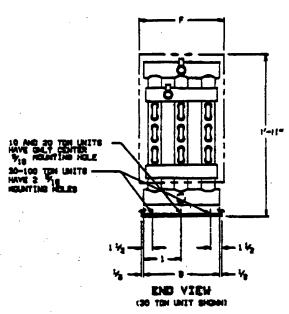
AIR COOLED RECIPROCATING UNITS
DESUPERHEATER / HATER HEATER
RDHA 1D THRU 100 TONS

(RDHA-5-1)

UNIT 2122	NO OF SECTIONS	A		5	REFRIC ID C	WATER CE	F	6	. 10	J	EST UNIT MEIGHT (LBS)	MITH CABINET (LB9)
15	J - ,	3'-8"	2	1'-5 1/2"	1 1/8	*	-2	4'-2"	4-04	4'-67	84	95
10-08	1	4'-8"	•	1. 2.48	1.76	70	24,	5'-0"	410 %	8'-4 %	77	114
20	,	30.		1'-5%	141	7/8	.2.	5'-2 1/2	4'-0 %	4-44	115	148
20-05	•	4'-6"		1 -3 74	1 1/2	76	474	6'-0%	4'-10%	5-47	137	177
30	,	36.		11-64	1 %	11/4	63/4	5'-2 1/1	4'-04	41-67	181	187
30-08		4'-6"	•		4.78	. 7	V 74	8'-0%	4'-10 %	5'-4 %	185	238
40		3'-8"		1'-5%"	15	1%	87,	5'-2 %	4'-04	4-44	212	353
40-08		48.		1 -3 74	. 70	, ,	74	6'-0 1/6	4'-104	51-45	253	580
50	5	3'-8"	10	1'-5%	1 %	12	10.2	3'-1/1"	4'-0%	4'-67	260	303
50-05		4'-6"			. 78	1 %	10%	6'-0 1/8	4'-10%	5 -4 7	310	950
80		30.	104	1'-8%"	21/2	1 %	11-03-0	8'-2 1/1	40 %	4-44	911	257
60-06		4.44			- 78	1.48	₹8 1'-0 ¥4	8'-0 1/6	0'-10	5'-4 %	389	422
80		36.	1'-4"	1'-5%	24.	24	1-47	5'-2/	4'-04	4'-0 %	411	482
80-01		4'-8"		74	- 7	2 1/8		6'-0%	4'-10	5'-4 76	467	\$47
100	10	3,-6.	1'-8"	1'-5%	24,	31/2	1'-8%	0'-2/2	41-04	4'-8 %	500	SAE
100-03		4'-9"		3 74	. 7	• 7	-87	6'-0%	4'-10 %	8'-4 %	602	969







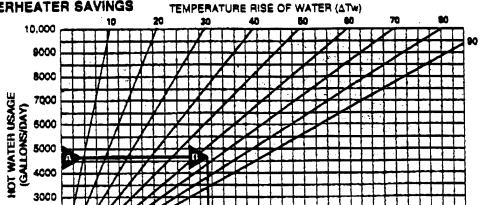
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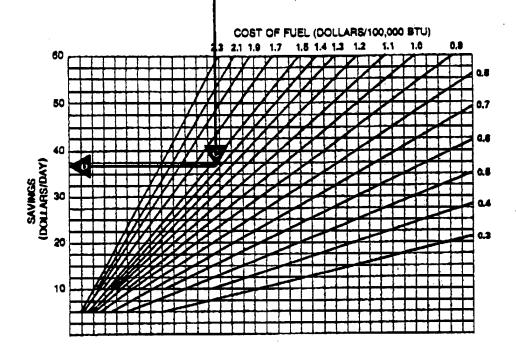


2000 1000 0

12

20 24 28





36 HEATING ENERGY SAVED (100,000 BTU/DAY)

### **EXAMPLE:**

- 1. A 40-ton unit operating at full capacity can generate 192 galions of hot water per hour when heated from 75 F to 140 F. This is equal to 4,608 gallions per day. Locate 4,608 gallions per day on the nomograph (point A).
- 2. The  $\Delta T_w$  is 140 F 75 F = 65 F. Follow the horizontal line at 4,608 gallons per day across to 65 FT, (point B).
- 3. Drop vertically to the lower section of the nomograph to the cost per 100,000 Btu. In this case let's use an electric water heater at \$0.05 per kwh to yield a cost of \$1.47 per 100,000 Btu (point C).
- 4. Run horizontally to the left to \$37/day savings (point D).
- 5. If this air conditioning unit operated at full capacity for 120 days per year, the desuperheater would provide the following yearly savings:

Depending on the installation, this savings could result in a payback period as low as one year!

### UP TO 12% HIGHER OPERATING EFFICIENCIES

But the energy savings derived from Trane desuperheaters continue beyond 'free' hot water. Desuperheaters also deliver increased unit efficiency.

Desuperheaters remove heat from the discharge gas before it reaches the condenser coil. This allows the condenser to work more efficiently and, in turn, allows your air conditioner to provide more cooling with the same amount of energy or less. Increasing your total unit operating efficiency by up to 12 percent!

### APPENDIX C-10 PREVENT AIR STRATIFICATION

### PREVENT AIR STRATIFICATION, ECO #10 BUILDING 512

### Given:

- from Bldg 207 simulation  $= 0.00342 \text{ MBtu} / \text{ft}^2$ Gas Savings Factor - from Bldg 207 simulation  $= -0.42832 \text{ Kwh} / \text{ft}^2$ Electric Savings Factor - from Bldg 207 simulation Demand Savings Factor = 0.0 kW - from utility rate analysis = \$4.67 / MBtu Gas Cost - from utility rate analysis = \$0.0255 / kWhElectric Cost - from utility rate analysis = \$8.85 / kWDemand Cost

### Peak Demand Savings:

 $(120,327 \text{ ft}^2)^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

### Annual Energy Savings:

- Gas:  $(120,327 \text{ ft}^2)*(0.00342 \text{ MBtu}/\text{ft}^2) = 412 \text{ MBtu}$ - Electric:  $(120,327 \text{ ft}^2)*(-0.42832 \text{ kWh}/\text{ft}^2) = -51,538 \text{ kWh}$ 

### **Annual Cost Savings:**

 $(412 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (-51,538 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$616 / \text{ yr}$ 

### **Estimated Construction Cost:**

\$ 194.37 per 1,000 sq. ft. \* 120,327 sq. ft. = \$23,388 \$23,388 + (\$23,388 \* 0.055 SIOH) + (\$23,388 \* 0.06 DESIGN) = \$26,077

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: PREVENT AIR STRATIFICATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:

DATE FIE

DESTRAT.WK3 DENNIS JONES 07/20/92 #3105.000

PRPARED BY: CHECKED BY:

							SIR		0.5	0.5	0.5	0.5	0.5	0.5	0.5						
					an and an an an an an an an an an an an an an	CONST.	COST	(\$)	32,357	4,334	36,175	16,606	2,167	26,078	117,717						
					TOTAL	ANNUAL	SAVINGS	<b>(</b> &)	749	9	838	382	25	604	2,726						
	MBtu/ft2	<pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre></pre> <pre>&lt;</pre>	«W/ff2		ANNUAL	NON-ENE	SAVINGS	(\$)	0	0	0	0	0	0	0						
SAVINGS	0.00342 MBtu/ft2	-0.42832 KWh/ft2	0.00000 KW/ft2		ANNOAL	DEMAND	SAVINGS	<b>(</b> 8)	0	0	0	0	0	0	]0						
		PWE	JPWE JPW	UPW		ANNOAL	ENERGY	SAVINGS	<b>&amp;</b>	749	9	838	386	20	604	2,726					
DISCOUNT FACTOR	14.45 UPWG	11.11 l 10.59 l		11.11 U 10.59 U		11.11 UPWE 10.59 UPW		11.11			TOTAL	ENERGY	SAVINGS	(MBtr.)	293	නි	327	150	8	236	1,066
	MBtu	\$4.67 MBtu \$0.0256 kWh \$102 66 kW		rRS	ANNOAL	NAT GAS	SAVINGS	(MBtu)	511	89	571	292	8	412	1,859						
ENERGY COST	\$4.67			\$0.0256 K \$102.66 K		\$0.0256 k \$102.66 k		\$4.67 N \$0.0256 k \$102.66 k		15	ANNOAL	ELECTRIC	SAVINGS	(KWH)	(63,948)	(8,566)	(71,495)	(32,819)	(4,283)	(51,538)	(232,650)
	)डा	AIC COST	<b>W</b> RGE		ANNUAL	DEMAND	SAVINGS	(KS)	0	0	0	0	0	0	0						
	NCREMENTAL GAS COST	INCREMENTAL ELECTRIC COST	ELECTRIC DEMAND CHARGE	LIFE		FLOOR	AREA	(EZ)	149,300	20,000	166,920	76,623	10,000	120,327							
	INCREMEN	INCREMEN	ELECTRIC I	ECONOMIC LIFE		BUILDING FLOOR	NUMBER AREA		202	102	214	400	401	512	TOTAL						

SIMPLE PAYBACK (YRS)

43.2 43.2 43.2 43.2 43.2 43.2

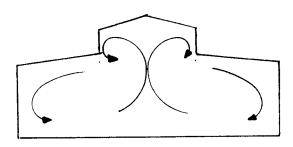
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SCALE	

### **DESTRATIFICATION FANS**

MFG DATA: 41,000 CFM fan for 5000 ft2, 20 feet high ceiling

$$\frac{41,000 \text{ ft}^3 60 \text{ MIN}}{(5000 \text{ ft}^2 * 20 \text{ ft}) \text{ hr min}} = 24.6 \text{ ACH}$$



Floor area Volume (22 ft ceiling) Measured Stratification 149,600 ft<sup>2</sup>
3,291,200 ft<sup>3</sup>
3°F @ 40°F outside air temp.

Increasing air changes to 25 ACH will likely result in 1°F of stratification.

$$\frac{25 \text{ ACH} * 3,291,200 \text{ft}^3}{60 \text{ min per hr}} = 1,371,333 \text{ cfm}$$

### OPTION 1:

Green Heck Ventilation unit is 40,000 cfm.

1,371,333 cfm = 34 units

40,000

Each unit has a 10 hp Green Heck motor. 10 hp \* 0.746 kW \* .85/.865 = 7.3 kW 34 units \* 7.3 kW = 248 total kW

### OPTION 2:

A 60" industrial ceiling fan has 41,000 cfm and costs considerably less.

1,371,333 cfm = 33 units

41,000

Each unit has a 145 watt motor.

<u>145 watts \* 33 units \* 1kW</u> =4.78 total kW

1000 watts

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EMC # 3105.000	OF
CALCULATED BY	DATE
CHECKED BY	DATE
SCALE	

### **DESTRATIFICATION FANS, COST ESTIMATE**

### **COSTS**

1 fan per 5000 ft<sup>2</sup> @ \$170 and 5 man hours per fan.

A total of 75 fans (15 per section) are needed.

Electrical use, 145 watts per 5000 ft<sup>2</sup> =  $0.03 \text{ W/ft}^2$ .

\$.08/ft<sup>2</sup> for wire and conduit.

FAN

34 + 1 man hour per 1000 ft<sup>2</sup>

POWER

\$80 per 1000 ft<sup>2</sup>

LABOR

\$60 per 1000 ft<sup>2</sup>

MATERIALS \$20 per 1000 ft<sup>2</sup>

COSI ESTIMATE ANALISIS	ANAL	SIS			_	NVITATION NO./CONTRAC	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING DATE APR 92	RICING 2	22-Apr-92	נ
White SOOS malls of a control of the	76.40					X CODE A	CODEB	CODEC		DRAWING NO.	G	SHT OF	
COATION Ft. McPherson & Ft Gillem						OTHER				ESTIMATOR PANG	SWG.	CHECKED BY CE	可可
									ST TANK	121	TOTAL	SHIPPING	(5
	Quantity	Tity.		LABOR	æ		EOOPMEN	-N-		1	5	ţ <u>c</u>	Total
ECO-10	§. Ø.	Chit	¥ Z	Total			rit (	1	Chit	, 5		<u>₹</u>	₹ . ₹
TASK DESCRIPTION	Units	Meas	Chit	Hrs	Price	Cost	Luice	3	3				
DESTRATIFICATION FANS									\$24 OO	\$34.00	\$54.88		
CEILING FANS	-	MSF	-	-	\$20.88				2000	\$20.00			
B ECTRIC SERVICE	-	MSF	ဗ	2.85	\$21.17	\$60.33			\$50.00	20.03			
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		<u> </u>	_							0.114	20.00		
SIBTOTAL						\$81.21				3.50		- 80	
OVERHEAD, BOND	15%	*				\$1218	80			\$5.40		2	
PROFIT	10%	*				\$8.12	2	ļ		\$67.50	5169.02	2	
COST SUB-TOTAL		-	_			\$101.52	2		-	\$10.13		5	
CONTINGENCY	15%	ж				\$15.23	3			\$77.63	\	7	
						\$116.75	2			2			

## **FOUR WAY FAN** One Fair Louis Functions: • Exhaus: • Supply • Recirculate FGRE GREENHECK-C-10.6

### **Four Way Fan**

## Model ESRMD Direct Drive - Roof Fan (Exhaust/Supply/Recirculation/Mix)

changes in temperature. The Greenheck Four Way fan offers the flexibility to meet changing needs and to maintain comfortable temperatures in factories, warehouses and other facilities with high ceilings. When temperatures change with production processes or seasonal shifts, the Four Way fan can exhaust, supply, recirculate or mix air as required.

### **Cost Savings**

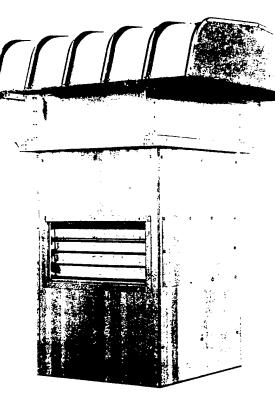
By exhausting excess heat, supplying cool air, recirculating stratified warm air, and mixing supply air with recirculated air, the Four Way fan also saves heating and cooling costs. When one fan offers four functions, further cost reductions result. Fewer fans required on the job means lower initial costs and lower installation costs, with fewer roof penetrations.

### Sizes

Model ESRMD fans are available in six sizes, 24"-54."

### **Performance**

Performance capacities extend from 4,000 CFM to 40,000 CFM and static pressures to 3/8". Performance in the exhaust, supply, and recirculate modes is equal.

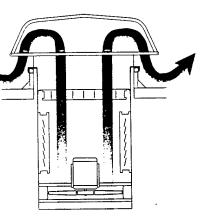


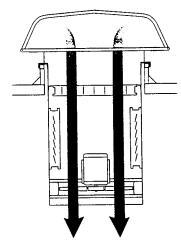
### **One Fan - Four Functions**



Evacuates excess heat to reduce cooling costs.

The exhaust/supply damper is open and the recirculation dampers are closed.





### 2. Supply

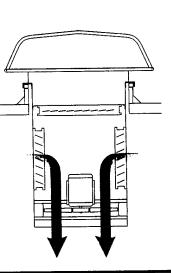
Fresh air can be supplied when outside temperatures are cooler (as at night) to reduce cooling

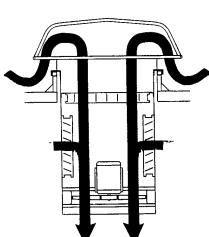
The exhaust/supply damper is open and the recirculation dampers are closed.

### 3. Recirculation

Destratifies warm air accumulated at ceiling level and directs it downward to reduce heating costs.

The exhaust/supply damper is closed and the recirculation dampers are open.





### 4. Mix

Comfortable temperatures can be maintained by tempering supply air with warmer air trapped at ceiling level.

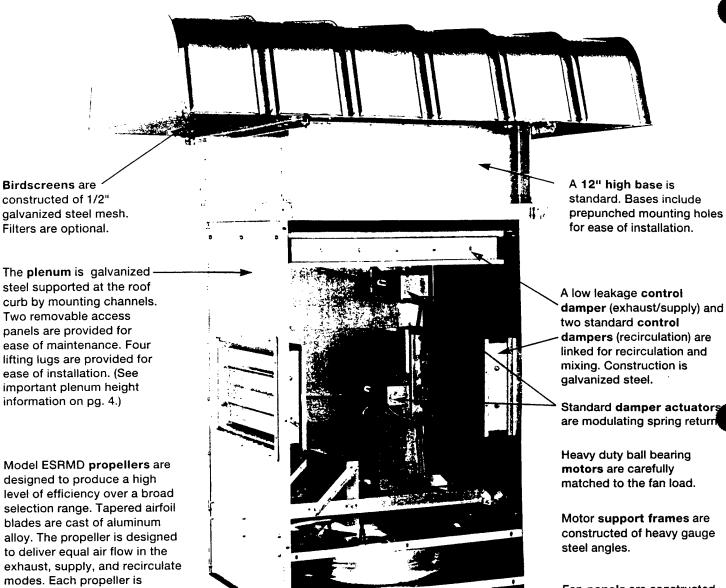
The exhaust/supply damper and the recirculation dampers are linked to work in combination.



### **CONSTRUCTION FEATURES**

Fan hoods and bases are constructed of galvanized steel. Aluminum construction is optional. Hood panels are arched and precision roll formed for strength and weather tightness. Hoods are bolted to heavy gauge support angles.

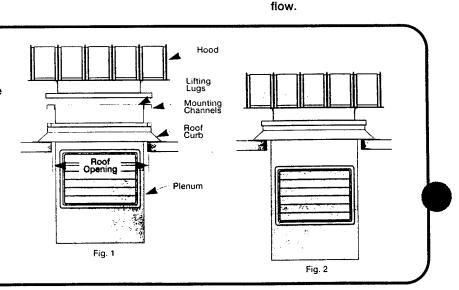
Hoods for all fan sizes except 54" ship fully assembled.



### **Installation Sequence**

balanced prior to assembly.

- 1. The roof curb is mounted and secured over the roof opening.
- The plenum (factory assembled) is lowered through the curb and roof opening until its mounting channels rest on the roof curb. Lifting lugs are provided. (Fig. 1)
- 3. The fan hood is lowered onto the curb/plenum assembly. (Fig. 1)
- 4. The hood and plenum are secured to the roof curb. (Fig. 2)



Fan panels are constructed

of heavy gauge steel with a double venturi for efficient air

3

## APPENDIX C-11 REPLACE STREET LIGHTS

LIFE CYCLE COS ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DAC FISCAL YEAR 1992 DISC ANALYSIS DATE: 09-02-92	N INVESTMENT P FT. GILLEM CA21-91-C-0097 CRETE PORTION	PROGRAM (ECIP REGION NOS ENERGY SAV NAME: ECO-11	. 4 CENSUS: VINGS OPPORT RPLACE STRE	1.06 3 UNITY ET LIC	SURVEY			
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	ST	: - 1D)		\$ \$ -\$ \$	2405. 133. 145. 0. 2683.			
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL		T COST & DISC	COUNTED SAVI	NGS				
UNIT COST FUEL \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR (4)	DISCO SAVI	OUNTED NGS (5)			
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	17. 0. 0. 0. 0.	\$ 126. \$ 0. \$ 0. \$ 0. \$ 0.	15.61 21.66 26.51 23.77 16.06		1962. 0. 0. 0.			
	17.			\$	1962.			
3. NON ENERGY SAVINGS (+)	/ COST(-)							
A. ANNUAL RECURRING (+/-) \$ 174. (1) DISCOUNT FACTOR (TABLE A) 14.53								
(2) DISCOUNTED SA	VING/COST (3A	X 3A1)		\$	2528.			
C. TOTAL NON ENERGY D	SAV	VINGS(+)/COST	(-) (3A2+3Bd4	)\$	2528.			
B IF 3D1 IS C IF 3D1B IS	ENERGY CALC (2 = OR > 3C GO	PF5 X .33) TO ITEM 4 SIR = (2F5+31) ITEM 4	D1)/1E) .9					
4. FIRST YEAR DOLLAR SAV	/INGS 2F3+3A+(	3B1D/(YRS EC	ONOMIC LIFE)	)\$	300.			
5. TOTAL NET DISCOUNTED	SAVINGS (2F5+	-3C)		\$	4490.			
6. DISCOUNTED SAVINGS RA (IF < 1 PROJECT DOES	NOT QUALIFY)				•			
* Project does not qualif	y for ECIP fu	inding; 4,5,6	for informa	tion	only.			

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 8.95

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO-11: REPLACE EXTERIOR LIGHTING

09/01/92 EXT\_LITES.WK3 JIM WATTERS

CHECKED BY: PRPARED BY:

#3105.000

EMC PROJECT:

DATE:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW
ECONOMICLIFE	25 YRS	
ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR		

	SIMPLE	PAYBACK	(YRS)		8.9	26.2	35.5	
		SIR			1.7	9.0	0.4	
	CONST.	COST	(\$)	0\$	\$2,682	\$176	"	
TOTAL	ANNOAL	SAVINGS	(\$)	\$0	\$300	\$7	\$256	
ANNOAL	NON-EN	SAVINGS	(\$)	0\$	\$174	0\$	0\$	
TOTAL ANNUAL ANNUAL ANNUAL	DEMAND NON-EN	SAVINGS	( <del>§</del> )	\$0	0\$	0\$	\$0	
ANNOAL	ENERGY	SAVINGS SAVINGS	(\$)	0\$	\$126	\$7	\$256	
	DEMAND ELECTRIC NAT GAS ENERGY		(MBtu)	0	17	-	34	
ANNUAL	NAT GAS	SAVINGS	(MBtu)	0	0	0	0	
ANNUAL ANNUAL	ELECTRIC	SAVINGS SAVINGS	(kWH)	0	4927.5	262.8	10019.3	
ANNOAL	DEMAND	SAVINGS	(kW)	0	0	0	0	
		Replacement	Bulb Type	400 HPS*	200 HPS*	360 HPS	150 HPS	
	Replacement	Existing Number Bulb Wattage Replacement SAVINGS	(WATTS)	400	200	360	150	
		Number	of Bulbs	0	S	2	122	
		Existing	Bulb Type of Bulbs (WATTS) Bulb Type	1500 QUARTS	500 QUARTS	400 MERCURY	175 MERCURY	
	Existing	Bulb Wattage	WATTS	1500	500	400	175	

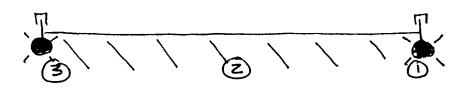
COST ESTIMATE ANALYSIS	NAI	SIS				INVITATION NO./CONTRACT NO.	CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	<u> </u>
						DACA 21 91 C-0097	-C-0097			DATE APR 92	Ŋ	22-Apr-92	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	ndy					X CODE A	CODEB	CODEC		DRAWING NO.		SHT OF	
LOCATION Ft. McPherson & Ft Gillem					1	OFFE				ESTIMATOR RMG		CHECKED BY CE.	명
	Quantity	ıtity		LABOR	82		EQUPMENT	ENT	MATERIAL	¶AL	TOTAL	SHIPPING	වු
EXTERIOR LIGHTING	No. Of	- Jij	Ή	Total	1		Unit		C.			Chit	Total
TASK DESCRIPTION	Units	Meas	Chit	Hrs	Price	Cost	Price	Cost	Price	Cost	00 0000	<b>X</b>	*
400 W HPS LAMP w/ FIXTURE	-	Ð	4	4	\$21.17	\$84.68			\$275.00	\$275.00	\$329.68		
OVERHEAD, BOND	15%					\$1270				\$41.25	\$53.95		
PBOFIT	10%					\$8.47				\$27.50	\$35.97		
COST SUB-TOTAL						\$106.85				\$343.75	Ĺ		
CONTINUENCY	15%					\$15.88				\$51.56	$\perp$		
TOTAL						\$121.73				\$395.31	\$517.04		
200 W HPS LAMP W/ FIXTURE	-	ð	4	4	\$21.17	\$84.68			\$250.00	\$250.00	\$334.68		
OVERHEAD, BOND	15%					\$12.70				\$37.50			
PBOET	10%					\$8.47				\$25.00	$\perp$		
COST SUB-TOTAL						\$105.85				\$312.50	*		
CONTINGENCY	15%					\$15.88				\$46.88			
TOTAL						\$121.73				\$359.38	\$481.10		
360 W HPS LAMP	_	<b>చ</b>	1	-	\$21.17	\$21.17			8	\$35.00	"		
OVERHEAD, BOND	15%					\$3.18				\$5.25			
PROFIT	10%					\$2.12				\$3.50			
COST SUB-TOTAL						\$26.46				\$43.75			
CONTINGENCY	15%					\$3.97				\$6.56			
TOTAL						\$30.43				\$50.31	\$80.74		
											646 17		
150 W HPS LAMP	-	Ą	-		\$21.17	\$21.17			S	\$43.00	$\perp$		
OVER-HEAD, BOND	15%					\$3.18 50.50				3 3			
PROFIT	8					* * * * * * * * * * * * * * * * * * *		-		\$31.25			
COST SUB-TOTAL	1					63.07				<b>3</b>	\$8.66		
CONTINGENCY	<u>R</u>					\$30.43				\$35.94	\$66.37		
IOIAL													
		_											
	-												
	-												

	Ε	М	CI	ENGIN	E	RS, II	٧(	С.
Denver	•	Cold	orado	Springs	•	Atlanta	•	Germany

JOB FI. MCPHERSON GILLEM
EMCH 3105,000
SHEET NO. \_\_\_\_\_\_OF

CALCULATED BY \_\_\_\_\_\_ DATE 7/21/92

STREET LIGHT READINGS PARKING LOT BEHIND B, 200





2.07 FOOTCANDLES

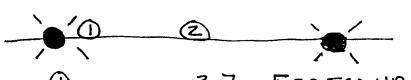
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STREET BEHIND PX



3.7 FOOTCANDUES

1.2

	_[	Ε	M	С	ENGINEERS, INC.	
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Denver • Colorado Springs • Atlanta • Germany

	PAERSON / EMC# 3105	5,000	
	Œ		
CHECKED BY		DATE _	
SCALE.			

STREET LIGHT I PARKING LOT	READINGS IN FRONT OF B 200
	3)
<u> </u>	2.07 FOOTCANDUES
2 -	0.17 "
3 —	O.33 "
<b>4</b> –	0.03

CROSS WALK IN FRONT OF BLDG 200

0.80 FOOTCANDLES

JOB _ F	I, McF	HERSO	IN /	GILL	.EM
		EMCT	1 31	05,0	000
				~-	

CALCULATED BY DATE 7/21/92

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

STREET LIGHT READINGS STREET IN FRONT OF B, 200

- 3,4 FOOTCANDLES
- " 0,13
- 3,4 - 11

STREET IN FRONT OF B, 168

- 0.17 FOOT CAN DUES 0.09 " 0.18 "

	E	M	С	Ε	NGINE	E	RS,	11	1(	D
Denver	•	Cold	orad	0	Springs	•	Atlant	а	•	Germany

JOB FT. N	1CPHERSON ( EMC # 310	5,000	_
SHEET NO.		OF	
CALCULATED BY	CEL	DATE 7/21/92	
CHECKED BY		DATE	_
SCALE			

	_	_	
CTOEET	LIGHT	READING	5

BLDG

PARKING LOT

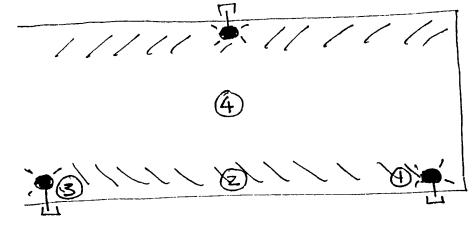


Fig. 14-18. Recommended Maintained Illuminances for Open and Covered Parking Facilities

			Open Parkin	g Facilities				
	F	or Vehlcular Ti	alfic	For Pede	strian Safety	Foi	Pedestrian S	ecurity
Level of Activity	Lux.	Footcan- dles*	Uniformity Ratio	Lux	Footcan- dles**	Łux*	Footcan- dles*	Uniformit Ratio
ow activity	5	0.5	4:1	2	0 2	9	0.8	5:1
Medium activity	1.1	1	3:1	6	0.6	22	2	5:1
ligh activity	22	2	3:1	10	0.9	43	4	5:1

Footcandles***	Lux*	Foolcandles <sup>4</sup>
5	54	5
10	54	5
50	54	5
	· =	· •

Average on pavement

the "High" activity lighting levels may be required, but while the game is being played or during hours of reduced activity the "Medium" or "Low" activity lighting levels may be adequate.

### ROADWAY ILLUMINATION DATA AND CALCULATIONS

The following is an example of a simple and straightforward calculation procedure to determine average illuminance and illuminance at a specific point on a roadway. For a detailed treatment of the subject, including calculations for high-mast and pedestrian walkway lighting, the reader is referred to Reference 1.

### Determination of Average Illuminance

The average illuminance over a large pavement area in terms of lux (footcandles) may be calculated by means of a "utilization curve" of the type shown in Fig. 14-19.

Utilization Curves. Utilization curves, available for various types of luminaires, afford a practical method for the determination of average illuminance over the roadway surface where lamp size, mounting heights, width of roadway, overhang and spacing between luminaires are known or assumed. Conversely, the desired spac-

ing or any other unknown factor may readily be determined if the other factors are given.

The Coefficient of Utilization, as shown in Fig. 14-19, is the percentage of rated lamp lumens which will fall on either of two strip-like areas of infinite length, one extending in front of the luminaire (street side), and the other behind the luminaire (house side), when the luminaire is level and oriented over the roadway in a manner equivalent to that in which it was tested. Since roadway width is expressed in terms of a ratio of luminaire mounting height to roadway width, the term has no dimensions.

Light Loss Factors. There are a number of causes of light loss. They are listed on page 4-21. For each cause, a factor can be determined. All individual factors can be multiplied together to obtain one total light loss factor. Some factors, usually due to less than ideal operating conditions, exist initially and continue through the life of the installation. They may, however, have too little effect to justify correction or be too costly to correct. The significant light loss factors in roadway calculations are:

Lamp Lumen Depreciation. Information about lamp lumen depreciation is available from manufacturers' tables and graphs for lumen depreciation and mortality of the chosen lamp. Rated average life should be determined for the specific hours per start; it should be known when burnouts will begin in the lamp life cycle. From these facts, a practical group relamping cycle will be established and then, based on the hours elapsed to lamp removal, the specific lamp lumen depreciation (LLD) factor can be determined.

<sup>\* \*</sup> Minimum on pavement

<sup>\*\*\*</sup> Average on payment—sum of electric lighting and daylight

## APPENDIX C-12 REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COST ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DACT FISCAL YEAR 1992 DISCT ANALYSIS DATE: 07-15-92	r ANALYSIS SUM INVESTMENT PF FT. GILLEM A21-91-C-0097 RETE PORTION RETE PORTION RECONOMIC LI	MMARY ROGRAN REG: ENI NAME: FE 15	1 (ECIP) ION NOS. ERGY SAVI ECO-12 F YEARS PI	STUDY: LCCID 4 CENSUS: INGS OPPORTUIVAC CONTROI REPARED BY:	GECO 1.0 3 JNITY LS KC	15 62 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	T	: <b>-</b> 1D	)		\$ \$ \$ -\$	51612. 2839. 3097. 0. 57548.
<ol> <li>ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL</li> </ol>	COST (-) , SAVINGS, UNI	T COS	T & DISC	OUNTED SAVI	NGS	
UNIT COST	SAVINGS	ANNU SAVI	IAL \$ INGS(3)	DISCOUNT FACTOR(4)	DIS	
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	973. 0. 0. 302. 0.	\$ \$ \$ \$	7272. 0. 0. 1410. 0.	11.11 14.26 16.89 14.45 11.21		80794. 0. 0. 20379. 0.
F. TOTAL	1275.	\$	8683.		\$	101174.
3. NON ENERGY SAVINGS (+	) / COST(-)					
				10.59	\$	5979.
A. ANNUAL RECURRING (1) DISCOUNT FAC (2) DISCOUNTED S	TOR (TABLE A) AVING/COST (3)	A X 3	A1)	10.00	\$	63318.
C. TOTAL NON ENERGY	DISCOUNTED SA	VINGS	(+)/COST	(-)(3A2+3Bd	4)\$	63318.
B IF 3D1 IS	Y QUALIFICATION OF THE PROPERTY CALC (SECOND SECOND	O TO SIR	ITEM 4 = (2F5+3	D1)/1E) 2.	87. 34	
4. FIRST YEAR DOLLAR SA	AVINGS 2F3+3A+	-(3B1D	/(YRS EC	ONOMIC LIFE	<b>())\$</b>	14662.
5. TOTAL NET DISCOUNTER					\$	164491.
6. DISCOUNTED SAVINGS I (IF < 1 PROJECT DOI	RATIO	( 8	SIR)=(5 /	' 1E)= 2.	.86	
7. SIMPLE PAYBACK PERIO			SPB=1E/4	3.	.93	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 12 -- HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

PREPARED BY: R. GERRANS

CHECKED BY:

FILE: ECO-12.WK3

EMC PROJECT: #3105.000 DATE: 15-Jul-92

15-Jul-92

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

		SIMPLE	AYBACK	(yrs)	3.9
		SIR	PA		2.9
		CONST SIR	COST	(\$)	\$57,547
	TOTAL	ANNOAL	SAVINGS	(\$/yr)	\$14,661
ANNOAL	NON	ENERGY	SAVINGS	(\$/yr)	\$127
•	ANNOAL	ENERGY DEMAND ENERGY	SAVINGS SAVINGS SAVINGS	(\$/yr)	\$5,852
	ANNOAL	ENERGY	SAVINGS	(\$/yr)	\$8,683
	TOTAL	ENERGY	SAVINGS	(MBtu/yr)	1,274
	ANNOAL	GAS	SAVINGS	(MBtu/yr)	302
	ANNOAL	BLDG # DEMAND ELECTRIC GAS	SAVINGS SAVINGS SAVINGS	(kWh/yr) (MBtu/yr)	285,187
	PEAK	DEMAND	SAVINGS	(kW)	22
		BLDG #			101

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 12 - HVAC Controls

CLIENT CONTRACT NO: DACA21 - 91 - C - 0097 CLIENT PROJECT ENG: TERRY SEABROOK

				2	- < - C -
				200	2 2 2
0	FOLIPMEN	*	COST	TOTAL	COST
9 *		l	(\$/ea)	(\$)	(\$)
#U+U+				\$51,612	\$57,547
5	DDC Panel	-	\$8,050.00		
	AHII	3			
	Chiller	9	\$3,577.00		
	Conv	1	\$4,384.00		
	Boiler	2			

EMC PROJECT: #3105.000 DATE:

FILE: ECO-12.WK3

PREPARED BY: R. GERRANS CHECKED BY:

EQUIPMENT COSTS:

\$8,050 \$3,154 \$3,154 \$9,192 \$3,577 \$4,384 \$4,127 **DDC Panel MZ AHU** Chiller Conv Boiler AHO FCU

(SUB-TOTAL) + (SUB-TOTAL \* .055 SIOH) + (SUB-TOTAL \* .06 DESIGN) = TOTAL COST

												0 4 0 7 0 0	2
COST ESTIMATE ANALYSIS	ANAL	SIS				NOLLA INVITATION N	INVITATION NO./CONTRACT NO.	<u>o</u> j		EFFECTIVE PHICING	HICING	16_4pr_92	3
							DACA 21-91-C-0097			0	7 mm	֝֞֞֝֞֝֞֝֞֝֟֝֝֟֝֓֓֓֞֝֟֝	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	S Study					X CODE A	CODE B	CODEC		DRAWING NO.	i.	<u> </u>	
LOCATION Ft. McPherson & Ft Gillem						O HER				ESTIMATOR RIMG	RMG	CHECKED BY CEL	CEL
	Afficer	ŧ		LABOR	ac		EQUIPMENT	AENT	MATERIAL	HAL	TOTAL	SHIPPING	G
AHU	S S	Ç.	¥	Total	Chit		Crit		Cnit			± 5	Total
TASK DESCRIPTION	Units	Meas	Chit	Hrs	Price	Cost	Price	Cost	Price	Cost		M	Š
	-	ŭ		4	21 17	\$31.76			\$118.00	\$118.00	\$149.76		
SIS	-  '	វ	3 0	5 6	2 47	642 34			\$160.00	\$160.00	\$202.34		
DTS	-  •	១ ១	7 00	0,0	21.17			-	\$370.00	\$370.00	\$412.34		
VALVE	-   *	5 5	200	200	24 47				\$66.00	\$66.00	\$108.34		
FAN DPS	-	5 🖽	20	2.0	21.17				\$59.00		\$101.34		
								-					
									\$94.00	\$470.00	\$470.00		
WIRE AND CONDUIT	٩					o out					\$750.00		
PROGRAMMING	သ					\$750.00							
			-										
		_											
								_					
		1				3004				\$1.243	\$2,194		
SUBTOTAL			-			6143				\$186			
CONTINGENCY	4CI					21.004				\$1,429	\$2,523		
COST SUB-TOTAL	1					\$164				\$214	\$378		
OVERHEAD, BOND	10%					\$109				\$143	\$252		
PROFIT	5		_			196.14				\$1,787	\$3,154		
SUBTOTAL		-				/96,18							
		$\frac{1}{1}$											
			-			\$1.367				\$1,787	\$3,154		
TOTAL THIS SHEET													

PROJECT Ft McPherson & Ft Gillem ESOS Study   LOCATION Ft McPherson & Ft Gillem   COLATION Ft McPherson & Ft Gillem   COLATION Ft McPherson & Ft Gillem   COLATION   Units   Meas Unit   Hrs   TASK DESCRIPTION   Units   Meas Unit   Hrs   STS   STS   Unit   EA   2.0   2.0   ST	OR Unit Price 21.17 21.17 21.17 5 21.17 5 21.17 5 21.17	Cost   St2.93   St2	CODE B CODE C CODE B CODE C Unit Price Cost	C DA DA DA DA DA DA DA DA DA DA DA DA DA	DRAWING NO.  ESTIMATOR RMG  AIAL  Cost  Cost  118.00  370.00  66.00  129.00  \$\$564.00  \$\$	7734 150 150 168 182 182 182 182	SHT OF CHECKED BY CEL SHIPPING Unit Total Wt Wt
ESOS Study   Quentity   No. Of   Unit   MH/   Units   Meas   Unit   EA   2.0   1   EA   2.0   1   EA   2.5   1   EA   2.5   6   6   6   6   6   6   6   6   6	OR Unit Price 21.17 21.17 21.17 5 21.17 5 21.17 5 21.17	CODE A OTHER Cost \$211.70 \$31.76 \$42.34 \$42.34 \$52.93 \$52.93	B			150 150 150 160 182 182 182	OKED BY COKED
Ouentity  No. Of Unit MH/ Units Meas Unit  1 EA 5.0  1 EA 2.0  1 EA 2.0  6 6 6	8 1000000	11.70 21.76 22.34 42.34 42.34 52.93 552.93	NOTICE OF THE PROPERTY OF THE			734 150 412 108 182 182 000.00	CHECKED BY CE SHIPPING Unit Wt Wt
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E E CONVERTER No. Of Unit MH/ Units Meas Unit MH/ Units Meas Unit EA 5.0 E		211.70 231.76 42.34 42.34 52.93 552.93					
SK DESCRIPTION       Units       Meass       Unit       HI         2       EA       5.0       1         6       1       EA       2.0         7       EA       2.0         8       1       EA       2.0         9       1       EA       2.5         AND CONDUIT       6       6       6         GRAMMING       6       6       6	0 0 0 0 0	211.70 231.76 42.34 42.34 552.93 552.93					
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E E 1 E A 1.5 P DPS 1 E A 2.0 P DPS 1 E A 2.5 E A 2.0		\$31.76 \$42.34 \$42.34 \$52.93 \$900.00		370 86 129 894.00			
DPS 1 EA 1.5  1 EA 2.0  1 EA 2.0  1 EA 2.0  1 EA 2.5  1 EA 2.6  1 EA 2.7  1 EA 2.6  1		\$42.34 \$42.34 \$52.93 \$900.00		370 66 68 173 894.00			
DPS  UND CONDUIT  WAMMING  BANKING  BAN		\$42.34		\$94.00			
DPS 1 EA 2.5  AND CONDUIT 6  RAMMING 6  1 EA 2.5  AND CONDUIT 6		\$52.93		\$94.00			
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		00'006\$		\$94.00			
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				-			
S. INTOTAL		\$1,281			\$1,769	•	
SOBIOTION 15%		\$182			\$265	_	
CONTINGENCIA		\$1,473			\$2,034	9	
COST SOUTH THE STATE OF THE STA		122\$			\$305		
OVERTICAL, BOARD		\$147			\$203		
		\$1.842	-		\$2,543	<b>\$4</b> ,384	
SUBIOIAL							
TOTAL TAILS SUCET		\$1,842			\$2,543	48,44	

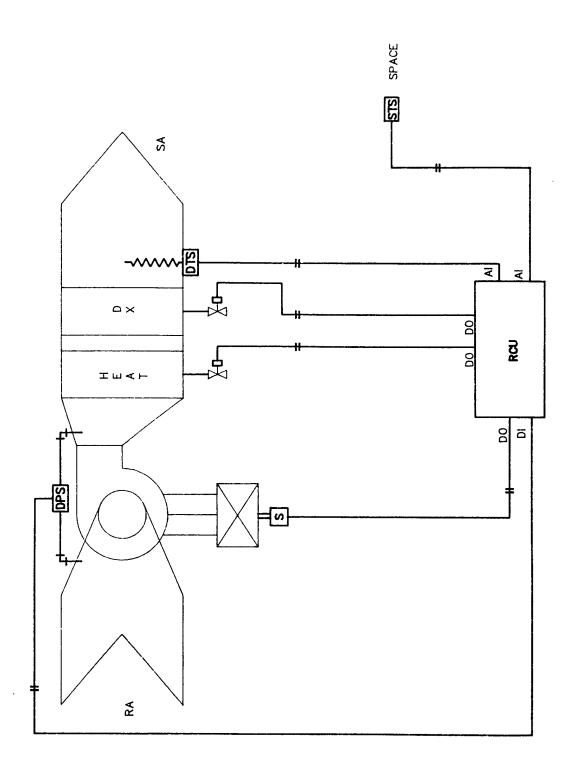
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LOCATION 11. Meriterson and chieff								į	ES	ESTIMATOR TIME	TOTAL	SHIPPING	1
M2 AHI	Quantity	.≥		LABOR			ECCIPMEN	- Z	2	2	<u>!</u>	tic.	Total
1	<del> </del>	i i	MH/ T		Unit	50	Unit Price	Cost	Price	Cost			₹
TASK DESCRIPTION	Conts	Meas	$\perp$	2	2	in							
	-	<b>V</b>	4	09	21.17	85			118	472.00	557		
STS		5 1	5 6	$\perp$	24 17	25			160	480.00	₹ 4		
DTS	_	5	2.0		; ;	5			370	740.00	782		
VALVE	_	<b>≦</b>	2.0	1	7	42			55	600.00	685		ļ
DAMPER	4	<b>a</b>	1.3		/1.12	3 8			98	99	87		
ST/SP	-	a a	2.0	$\perp$	21.17	7			or.	59.00	8		
FAN DPS	-	<b>∆</b>	2	2.0	21.17	21			3				
											20 000		
# discourant	7								\$94.00	\$1,410.00	41,410.00		
WIRE AND CONDUIT	2		-			42 250 OO					\$2,250.00		
PROGRAMMING	15					\$2,630.00							
	_							-					
								-					
				+									
				+									
			-	+		£0 568		-		\$3,827	\$6,395	19	
SUBTOTAL				+		OCC.				\$574	\$359	0	
CONTINGENCY	15%		+	+		62 OF 3				\$4,401	\$7,354	4	
COST SUB-TOTAL			+			36.1300 24.40				099\$	\$1,103	3	
OVERHEAD, BOND	15%		-			244				\$440		2	
PROFIT	10%		$\frac{1}{1}$			CECTO				\$5,501	\$9,192	2	
SUBTOTAL						\$3,681					_		
			-										
			-					-					
										\$5.501	\$9.192	2	
		L	-	_		163 63	_						

ı				_		70U-0-10-10 VVV	7000-0-			DATE APR.	28	16-Apr-92	
	1					X CODE A	CODE B	CODEC		DRAWING NO.	Ċ	SHT OF	
PROJECT Ft. McPherson & Ft. Gillem ESUS Study	ome er				1	T		1	— 1			70 027071	ũ
								TIVE	MATER	MATERIA! TO	TOTAL	IZ	1
SHITES	Quantity	tty		LABOR	- 1		בובים ביים	JULIA	1		! : )	Linit	Total
- 1	Š.	C Sit	/HW	Total	Pic C	) Se	Price	So	Price	Cost		¥	₹
TASK DESCRIPTION		Meas	<b>E</b>		2								
O. L.	2	ā	5.0	10.0	21.17	42			261	522.00	\$6		
N N		E E	2.0	2.0	21.17	21			98	96.00			
S1/SF	•	I A	2.5	25	21.17	21			129	129.00	₹ 1		
PUMP DPS	- 0	5 4	0 -	20	21.17	42			8	180.00	83		
STATUS RELAY	3	5	!										
			-										
TI MINOS GIAN TOWN	9								\$94.00	\$564.00			
WINE AND CONDOIL	9					\$900.00					\$300.00		
PHOGHAMMING													
								-					
			1										
			1										
								1					
			-										
											_		
SILETOTAL						\$1,027				\$1,461	-		
CONTRICTION	15%					\$154				SLX\$	1		
CONTRACTION TOTAL						\$1,181				\$1,680	1		
COSI SOB-ICIVE	450					1111				\$252			
OVEHHEAD, BOND	2 2					\$118	-			\$168		9	
PROFIT	2					£1 476	44			\$2,100	53,577	7	
SUBTOTAL													
								-	 				
										\$2,100	53,577	7	
TOTAL THIS SHEET						\$1,476	2						

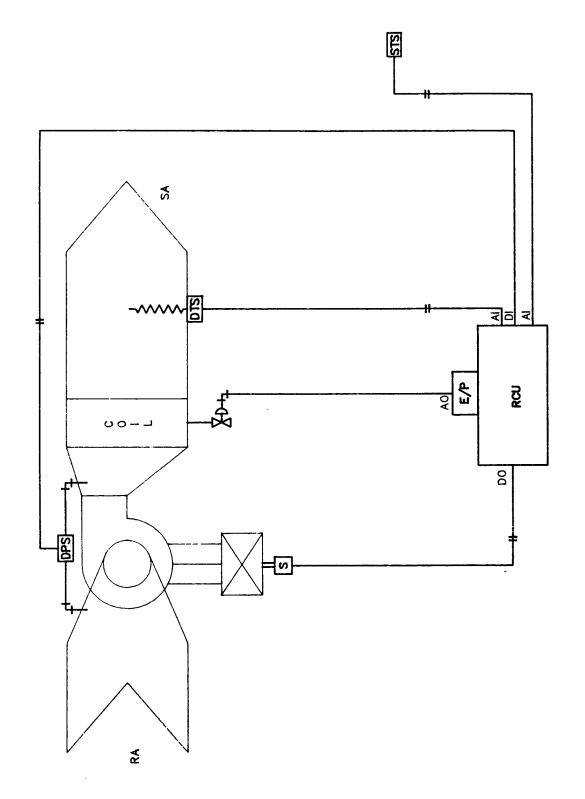
COST ESTIMATE ANALTSIS	ANAL	<u> </u>			_	INVITATION NO./CONTRACT NO.	CONTRACT NO			EFFECTIVE PRICING DATE APR. 92	HICING	16-Apr-92	3
4149 3033 mallo 43 8 man 1611 43 1621 626	4.40					X CODE A	CODE B	CODEC		DRAWING NO.		SHT OF	
PHOUSEL FL MCPHBRSON & FL GINBER ESC	oma)				-1	$\top$		· · · · · · · · · · · · · · · · · · ·					
LOCATION Ft. McPherson & Ft Gillem					_	, 1				<b>ESTIMATOR RMG</b>	₹MG	CHECKED BY	딩
BOILEB	Quantity	Aift		LABOR			EQUIPMENT	ENT	MATERIAL	JAIL	TOTAL	SHIPPING	<u>o</u>
	O.S	, E	Ή¥	Total	Crit		Ç		Sit C			<u> </u>	Total
TASK DESCRIPTION	Cuits		Chit	FL	Price	Cost	Price	Sost	Price	Cost		ž	ξ
									ğ	500 00	795		
WTS	2	<b>a</b>	2.0	10.0	21.17	42			107	200.00	\$ 5		
STS	-	ស	1.5	1.5	21.17	21			911	18.6	82		
ST/SP	-	2	2.0	2.0	21.17	21			98	06.00	87		
SdU dWi ld	-	ā	2.5	2.5	21.17	21			129	129.00	150		
STATIS BEI AY	8		1.0	2.0	21.17	42			8	180.00	83		
		$\rightarrow$											
									30,00		00 000		
WIRE AND CONDUIT	7								\$94.00	\$000 M	00.000¢		
PROGRAMMING	7					\$1,050.00					\$1,050.00		
			-										
			+										
								+					
			1										
						90,19				\$1.673	\$2,871		
SUBTOTAL	100		-			24.00				\$251	\$431		
CONTINGENCY	80					S1 378				\$1,924	\$3,302	0.1	
COSI SUB-TOTAL						2009				\$289	\$495		
OVERHEAD, BOND	40L		+			1034		<u> </u>		\$190	\$330		
PROFIT	10%					9519				en 405			
SUBTOTAL						\$1,722				CO+,26			
										40.405	44 197		
TOTAL SINE COLUMN						\$1,722				¥,400			

C-12.8

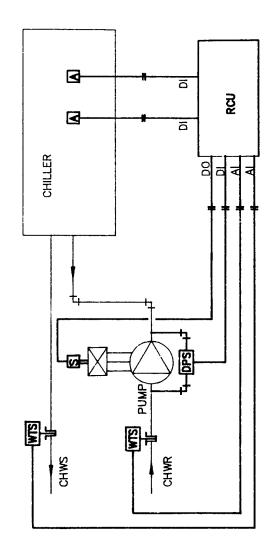
Automatical Continue	COST ESTIMATE ANALYSIS	NAL	SIS			_	NVITATION NC	INVITATION NO./CONTRACT NO.			EFFECTIVE PHICING DATE APR. 92	RICING 92	A A	۱ ہ
OTHER	- 1	μφ						CODE B	SODE C		DRAWING N	ď	PA OF	
WER         1 ABOR         LABOR         LORD         Unit         LORD         Unit         ANTERNI         TOTAL           Units         Mass         Unit         Hrs         Price         Cost         Unit         Cost         Cost         S600         S6000         S600	LOCATION Ft. McPherson & Ft Gillem						OTHER				ESTIMATOR	RMG	CHECKED BY	CEL
No. Ol unith Multi Trial Unit Unit Unit Unit Unit Multi Trial Price Cost 5,600 5600.00 5,600			-					Mdii	FNT	MATE	RIAL	TOTAL	SHIPPING	<u>ග</u>
No. Cr		3	묻ᆫ			- 1		Unit		Ç	1		ig S	Total
1	ļ	5 <u>2</u> 5 5		E Z	2 E	Price	Cost	Price	Set	Price	Cost		₹	<b>₹</b>
1   1   1   1   1   1   1   1   1   1	I ASK DESCRIPTION									5,600		5,600		
15% \$56.00 15% \$6.40 16% \$6.40	PER BUILDING INCLUDING LABOR, POWER									200				
900 088 900 08 9	CONNECTION, ENCLOSURE			1										
DIAL 15% 86.440  DIAL 15% 86.440  10% 85.600														
DIAL 15% 86.40  ND 115% 85.60  ND 115% 85.60  ND 115% 85.60  SECOND 15% 85.60  SECON														
DIAL 15% 85.600				1										
NATE 115% 85.000 880.0												-		
DIAL 15% 85.640														
DTAL 15% 85,600 WID 10% 88,000 HEET														
77AL 15% 8.6440 MD 15% 8.6440 MD 15% 8.6440 MD 15% 8.66440   MD 15% 8.66440000 MD 15% 8.66440000000000000000000000000000000000														
77AL 15% 85,600														
77AL 15% 85,600 WD 10% 86,440 10% 86,640 10% 86,640 10% 86,640 10% 86,640 10% 86,640 10% 86,640 10% 86,640														
DIAL 15% 5640  ND 10% 56440  10% 56440  10% 56440  10% 56440  10% 56440  10% 56440  10% 56440  10% 56440  10% 56440  10% 56440														
DIAL 15% 85,600  DIAL 15% 86,440  DIAL 15% 86,440  BEST 86,600														
DTAL 15% 86.440  WD 10% 86.440  86.440  86.440  86.40  86.40  86.40  86.40  86.40  86.40  86.40  86.40  86.40											-			
DTAL 15% 85,600														
OTAL 15% 8840 ND 15% 88644 ND 10% 88644 HEET									-					
OTAL 15% 8840  OTAL 15% 86440  ND 15% 86440  HEET										-				
DTAL \$5,600 SMD 15% \$6,440 DTAL \$986 ND 15% \$6,440 S6,440											-			_
DTAL 15% 85,600  OTAL 25% 86,440  OTAL 25% 86,440  OTAL 25% 86,440  OTAL 25% 86,440  S6,440  S6,640		 												_
DTAL 15% 86.440  DTAL 15% 86.440  NID 10% 86.440  SEGON 86														
DTAL \$5,600 SMD 15% \$6,440 SMD 10% \$6,440 SHEET														
STAL       \$5,600         DTAL       \$6,440         NID       \$6,440         NID       \$6,440         \$644       \$644         \$644       \$644         \$644       \$644         \$644       \$644         \$645       \$646         \$646       \$64050									+					
DTAL ND 15% ND 16% ND 1											\$5,60		8	$\dashv$
DTAL NID 15% S6,440 86,440 10% S644 S644 S644 S644 S644 S644 S644 S64	SUBTOTAL										48\$		2	-
15% \$966 10% \$644	CONTINGENCY	159	9								\$6,4		Q	
15% \$644	COST SUB-TOTAL		1								96\$		98	
\$8,050	OVERHEAD, BOND	13	٩								\$64		3	1
090'8\$	PROFIT	5	92								\$8,05		8	-
050,88	SUBTOTAL		1											_
88'020			+			-								-
TOTAL THIS SHEET			_						ļ		\$8,05		8	4
	TOTAL THIS SHEET													



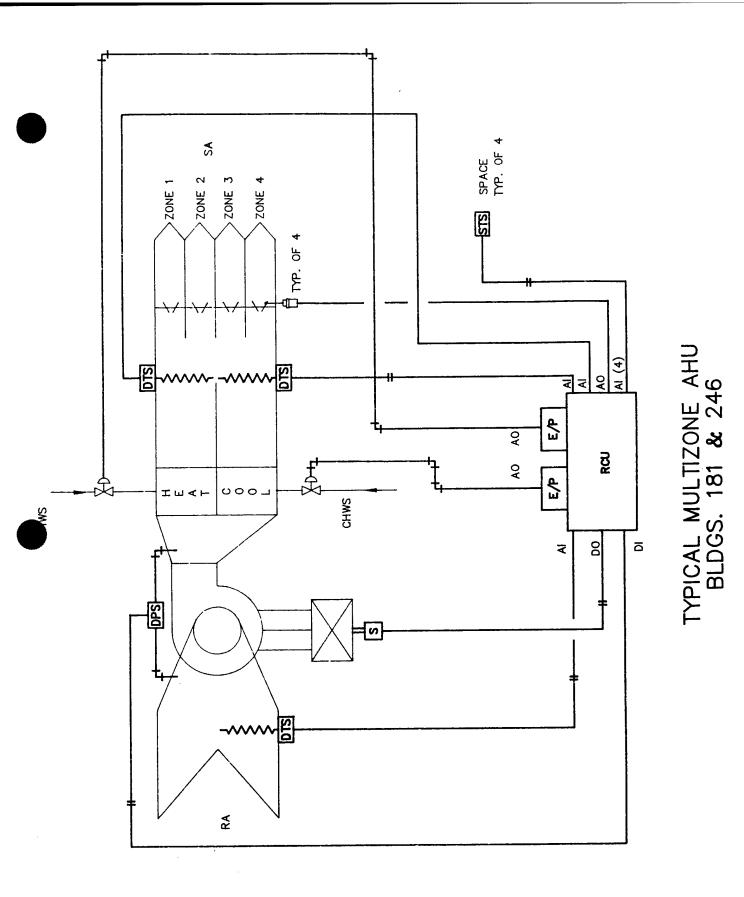
TYPICAL SINGLE ZONE AHU

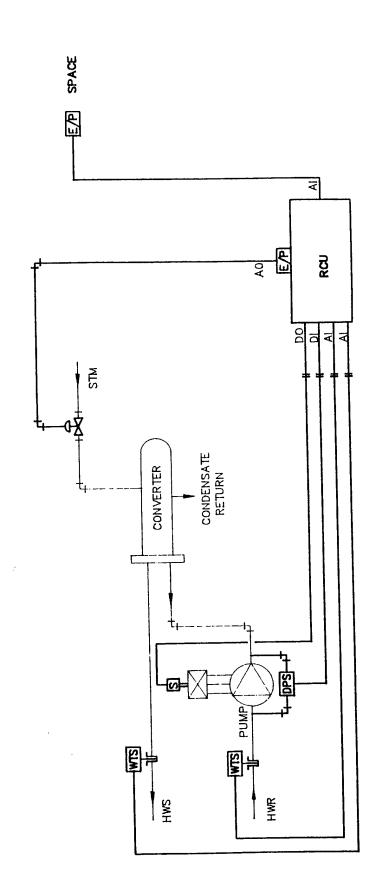


TYPICAL AHU BLDGS. 184, 60, 56, 58, 62, 100, 101, 358, 500 & 514

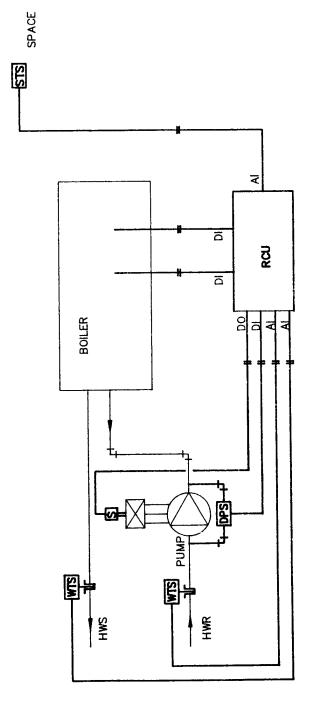


TYPICAL AIR COOLED CHILLER BLDGS. 184, 181, 246, 60, 168, 171, 170, 358 & 500





TYPICAL STM/HW CONVERTER BLDGS. 181, 60, 168, 171, 170, 131, & 61



TYPICAL HW BOILER BLDGS. 184 & 246

VAV - BUILDING 200

	E	M	С	ENGINE	E	RS,	IN	C.
Denver	•	Cold	orad	lo Springs	•	Atlan	ta •	Germany

JOBFT.	MCPHERSON/GILLEM	ESOS STUDY	
	EMC#3105.000		
SHEET NO	- Control of the Cont	OF	
CALCULATED BY .	CEL	DATE _7/21/92	
CHECKED BY		DATE	
SCALE			

### LABOR SAVINGS:

An estimated 6 hours per year labor (non-energy) savings were taken due to a reduction in temperature (too hot-too cold) related services calls.

(6 hours per year per building) x \$21.16 per hour = \$127 per year per building

## APPENDIX C-13 THERMAL STORAGE

EMC PROJECT: DATE: FILE:

#3105.000 07/20/92 ICE.WK3 DENNIS JONES

PRPARED BY: CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097  CLIENT PROJECT ENG: TERRY SEABROOK  ENERGY  COST  ENERGY  FACTOR	
ă	
	DISCOUNT
	14.45 UPWG
INCREMENTAL ELECTRIC COST \$0.0255 kWh 11.11 UPW	11.11 UPWE
ELECTRIC DEMAND CHARGE \$102.66 kW 10.59 UPW	10.59 UPW
ECONOMIC LIFE 15 YRS	

									_4
							SIR		0.4
						CONST.	COST		\$349,748
					TOTAL	ANNOAL	SAVINGS	(%)	\$0 \$11,939
TOTAL	COST	(\$)	313675		ANNOAL	DEMAND NON-ENE	SAVINGS	(&)	0\$
MATERIAL	COST	(\$)	219000		ANNOAL	DEMAND	SAVINGS	(&)	\$12,935
CHILLER	COST	(%)	64675		ANNOAL	ENERGY	SAVINGS	(%)	(966\$)
STORAGE	COST	(\$)	30000		TOTAL	ENERGY	SAVINGS	(MBtu)	(133)
STORAGE STORAGE CHILLER MATERIAL	SIZE	TON-HRS	260		ANNOAL	NAT GAS	SAVINGS	(MBtu)	0
		TONS) (TON-HRS (TON-HRS	751		ANNOAL	DEMAND ELECTRIC	SAVINGS	(KWH)	(690'66)
BUILDING FLOOR CHILLER STORAGE	SIZE	(TONS)	120		ANNOAL ANNOAL	DEMAND	SAVINGS	(kW)	126
FLOOR	AREA	(ft2)	120,182			FLOOR	AREA	(FT2)	120,182
BUILDING	NUMBER		101			BUILDING	NUMBER		101

LABOR &

ACTUAL

REGD

SIMPLE PAYBACK (YRS) 29.3

Denver • Colorado Springs • Atlanta • Germany

JOB Ft. McPherson / Ft. G: EMC # 3105.000	illem ESOS Study
SHEET NO.	OF
CALCULATED BY	DATE
CHECKED BY	DATE
SCALE	

# ECO 13

# G101

Floor Area = 120,182 ft<sup>2</sup>
Tank Capacity = 751 ton\*hrs
Chiller Capacity = 125 tons
Demand Savings = 126 kw
Electricity Used = 39,069 kwh/yr

### M 060

Floor Area = 20,856 ft<sup>2</sup>
Tank Capacity = 111 ton\*hrs
Chiller Capacity = 20 tons
Demand Savings = 22 kw
Electricity Used = 9399 kwh/yr

# M 170/171

Floor Area = 35,398 ft<sup>2</sup>
Tank Capacity = 248 ton\*hrs
Chiller Capacity = 45 tons
Demand Savings = 60 kw
Electricity Used = 16,246 kwh/yr

# M 500

Floor Area = 27,466 ft<sup>2</sup>
Tank Capacity = 205 ton\*hrs
Chiller Capacity = 35 tons
Demand Savings = 46 kw
Electricity Used = 13,122 kwh/yr

# HAYNES TRANE

DATE:	4/12/92
TIME:	11:30

6654 Greenwood Plaze Bivd. Englewadd, Coloredo 80111-2388 303/779-0787 303/779-0714 (FAX)

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	number of	ing sent:_	<u> </u>	cluding	this p	page)
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UE ( 3 TH (E3 TH (E

# PROPOSAL

The Trane Company A Division of American Standard Inc.

TRANE COMPANY 5654 GREENWOOD PLAZA BLVD. ENGLEWOOD, COLORADO 80111-2385

Customer

Number

Dete

EMC ENGINEERS FAX NO:

EMC ENGINEERS

ATLANTA

4/10/92

Job Name

FORT MCPHERSON

ATTN: DENNIS JONES

Delivery Terms

FOB: FACTORY FREIGHT ALLOWED

Terms of Payment

NET: 30 DAYS

BUILDING 181 BUDGET

ITEM: A

Engineer

QTY: 1

DESCRIPTION: TRANE AIR COOLED CHILLER

TAG (S): 40 TON

>

- 40 TON A/C COLD GENERATOR
- ICE MAKING CONTROL MICROPROCESSOR
- UL LISTED
- PRESSURE GAUGES
- FLOW SWITCH
- CONTROL POWER TRANSFORMER

ITEM: B QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS TAG (S):

- QTY: 2 MODEL 1190 TANKS
- SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS A TO B \*\*\*\*\*\* \$ 115,000

Effective March, 1987, price incresse terms will be administered as follows: Prices stated in this proposal are firm provided that notification of release for immediate production and shipment is received at the factory not later than five months from order receipt. If such release is received later than five months from order receipt date but within eight months of order receipt date, prices will be increased a streight 1.0 percent (not compounded) for each one-manth period (or part thereof) beyond the five-month firm

price period up to the date of receipt of such release. If such release is not received with eight months after data of order receipt, the prices are subject to renegotiation or at the Company's option, the order will be cancelled. If for any reason Buyer delays shipment after release, prices are subject to increase as atmed on the reverse side hereof.

Prices do not include texes. See reverse side for terms and conditions of sale upon which this proposal is based.



# PROPOSAL

NumbarLANTA

Page

The Trane Company ision of American Standard Inc.

BUILDING 184 BUDGET

History Control of the Control of th

ITEM: C QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER

**TAG** (S):

50 TON

50 TON A/C COLD GENERATOR

- ICE MAKING CONTROL MICROPROCESSOR
- UL LISTED
- PRESSURE GAUGES
- FLOW SWITCH
- CONTROL POWER TRANSFORMER

: D QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS

QTY: 2 - MODEL 1190 TANKS

SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS C TO D ..... \$ 123,000

BUILDING GT6 BUDGET

ITEM: E QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER

TAG (S):

40 TON

40 TON A/C COLD GENERATOR

ICE MAKING CONTROL MICROPROCESSOR

UL LISTED

PRESSURE GAUGES

FLOW SWITCH

CONTROL POWER TRANSFORMER

C-13.5

ITEM: F QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS

TAG (C)

TRANE

# **PROPOSAL**

The Trane Company
A Division of American Standard Inc.

NumATLANTA

Page

3

QTY: 2 - MODEL 1190 TANKS

> SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS E TO F ..... \$ 115,000

State and Local taxes are not included in above price RESPECTFULLY SUBMITTED,

RC14

ROGER C. HUBERT SALES ENGINEER PRECT:

FORT MOPHERSON

ANALYSIS BY

DAN MCGUINNESS

ROGER HUBERT - HAYNES TRANE 5654 GREENWOOD PLAZA BLVD. ENGLEWOOD, CO 80111-2385 (303) 779-0787 303 303 232 (4 2

FILE #DENO050D SLDG. 184

04-10-1992

(C) Calmac Mfg. Corp., 1990. 411 Rights Reserved.

> (C) Calmac Mfg. Copp., 1990. All Rights Reserved.

**************************************			DESIGN DA	Y LOAD	DATA		
HOUR LOAD		UR LOAD TYPE CHIL		HOUR	LOAD	TYPE	CHILL %
1	6.30	I	65.0	13	42.20	F	0.0
2	5.60	I	65.0	14	54.10	F	0.0
. 3	5.00	1	65.0	15	53.70	F	0.0
4	4.60	I	65.0	16	54.60	F	0.0
. 5	4.40	I	65.0	17	48.20	P	100.0
6	8.90	I	65.0	18	28.00	P	100.0
7	16.30	P	100.0	19	11.80	I	65.0
. 8	46.40	P	100.0	20	11.00	I	65.0
9	48.10	P	100.0	21	9.90	I	65.0
10	49.50	P	100.0	22	8.80	I	65.0
11	50.80	P	100.0	23	7.80	I	65.0
12	50.20	P	100.0	24	6.90	I	65.0

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(C) Galmac Mfg. Corp., 1990.
All Rights Reserved.
                           HOUR OF DAY
LEVLOAD TANK MODEL
                                                1190
DESIGN LOAD
                                                54.6
SYSTEM SUPPLY TEMPERATURE (DEG F)
                                                45
SYSTEM RETURN TEMPERATURE (DEG F)
                                                55
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL)
                                                100
DEFAULT CHILLER ICEMAKING CAPACITY (X OF NOMINAL)
                                                45
NUMBER OF CODLING HOURS
                                                12
NUMBER OF ICE-MAKING HOURS
                                                12
TOTAL COOLING LOAD (TONSHIRS)
                                               633.1
```

OHLR TUNS	COOL CAP TONS	ICE CAP TONS	STRO	ESTMID TON HOURS	STRG INLET DEG F	STRO OUT DEG F	PEAK STRG TONS	MIN # TANKS	MAX # TANKS
42.67 60.00	42.67 60.00	27.73 39.00	0.37	127.00 128.00	55.00 5 <b>5.</b> 00	45.00 45.00	54.60 54.60	1.87	1.87 2.95

(C) Calmac Mfg. Corp., 1990. All Rights Reserved.

# DESIGN DAY SYSTEM ANALYSIS

HIMER UPSTREAM - SERIES	FLOW	NOMINAL CHILLER	SIZE = 40.0
SYL 1 SUPPLY TEMPERATURE	<b>= 45.0</b>	NUMBER OF TANKS	= 2 MODEL 1190
SYSTEM RETURN TEMPERATURE		DESIGN LOAD =	54.6 TONS
'LOW (GPM) - DISCHARGE =	139.2	CHARGE = 139.2	2
PELTA P (PSI) - DISCHARGE	9.2	CHARGE = 10.5	

10U & 'Y₽'	E	TONS	CHLR	BTRO	TANK TONS	TN-HRS TOTAL	TN-HRS/ TANK	CHARGE	TEMP		MIN TEMP	RET TEMP		PD PSI FO	
1		6	39	33	16.3		105.2			30.5	30.5	31.7	69.6	10.6	
1	-	6	39	33	16.7	!	121.9			29.8			69. <b>6</b>	10.6	
3		5	39	34	17.0	1	138.9			28.8		29.7	69.6	10.7	
4		5	39	34	17.2	i	156.1	82.2	21.3	27.6	27.6	28.4	69.6	10.7	
5		4	39	35	17.3	1	173.4	91.3	19.7	26.0	26.0	26.8	69.6	10.8	
6		9	22	13	6.6	1	180.0		***		***	***	69.6	****	
7		16	1.6	Ç	0.0		180.0	94.7	45.0	45.0	32.0	48.0		***	
8		46	46	¢	0.0	360	180.0					53.5		***	
9		48	48	Q.	0.0	360	180.0					53.8		****	
.0	P	49	49	Ö	0.0	360	180,0	94.7	45.0	45.0	32.0	54.1		****	
. 1		<b>55</b> i	馬士	Q.	0.0	360	180.0	94.7	45.0	45.0	32.0	54.3		****	٠.
.2		50	50	Ò	୦.ପ	360	180.0	94,7	45.0	45.0	32.0	54.2	0.0	****	
.3	F	42	0	-42	-21.1	318	158.9	83.6	52.7	45.0	33.3	52.7	27.7	2.6	
14		54	Q		-27.1	1	131.8					54.9	36.0	3.5	
15		54			-26.9		105.0					54.8	37.1	3.9	
16	F	55	o o	-55	,	:	77.7	40.9	55.0	45.0	39.5	<b>55.</b> 0	44.9	4.7	
17		48	48	Q	0.0							53.8	0.0		
		28	28	Q	0. ¢	1	77.7	40.9	45.0	45.0	32.0	50.i		***	
19	I	12	39	27	13.6	1	13.6					34.0		10.4	
20	I	11	3.0	28	14.0	55	27.6			31.7				10.5	
21	I	10	39	29	14.5	84	42.1	22.2	26.3	31.6	31.6	33.5		10.5	
22	I	9	.39	30	15.1	114	57.2					33.1		10.5	
23	1	8	28	31	15.6	146	72.8					32.8		10.5	
24	I	7	39	32	16.0	178	88.9	46.8	25.1	31.0	31.0	32.3	69.6	10.5	

# TANK DISCHARGE PROFILE

303 800 404 44 3

HOUR	TONS	INLET	OUTLET	PERCENT	OUT
&	PER	TEMP	TEMP	TANK	OF
Type	TANK	DEG.F	DEG.F	DISCH.	RANGE
13 F 14 F 15 F 16 F	21.1 27.0 26.9 27.3	52.7 54.9 54.8 55.0	45.0 45.0 45.0 45.0 45.0	11.1 25.3 37.5 53.8	<b>机合物系统系统通应线接</b>

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60

TON CHILLER -

- FLOW ANALYSIS -

	 	;					
HG dT	CHG GPM	GPM/TANK	dF(PSI)	AVG LCWT	MIN LOUT		
3.0 4.0 5.0 6.0 7.0 8.0 9.0	331.5 248.6 198.9 165.8 142.1 124.3 110.5	165.8 124.3 99.4 82.9 71.0 62.2 55.3 49.7	17.2 14.1 10.9	**** **** 23.7 23.0 22.4 21.7 21.0 20.2	#### #### 20.7 20.3 19.9 15.5 19.1		
	DIS dT	DIS GFM	GFM/TANK	dP(FSI)			
	8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0	174.0 154.7 139.2 126.6 116.0 107.1 99.4 92.8	87.0 77.3 69.6 63.3 58.0 53.5 49.7	12.6 10.4 8.7 7.5 6.5 5.7 5.1			

2 MODEL

1170 STORAGE TANKS

'R CTI

FORT MCPHERSON

MALYSIS BY:

DAN MCGUINNESS

ROGER HUBERT - HAYNES TRANE 5654 GREENWOOD PLAZA BLVD. ENGLEWOOD, CD 80111-2385 (303) 779-0787

TLE #DENCOSCD LDG. GT6

4-10-1992

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			DESIGN DA	Y LOAD D	)ATA		- <b>4.4</b>
HOUR	L.OAD	TYPE	CHILL %	HOUR	LOAD	TYPE	CHILL %
1234567890112	7.20 6.40 5.90 5.50 5.40 7.40 10.20 26.70 32.10 34.00 35.00		45.0 45.0 45.0 45.0 45.0 100.0 100.0 100.0	13 14 15 16 17 18 19 20 21 22 23 24	32.80 37.40 41.30 40.30 34.50 23.20 10.10 9.20 8.50 7.90 7.40 7.00	F F F P P I I I I I I I I I I I I I I I	0.0 0.0 0.0 100.0 45.0 45.0 45.0

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                                    HOUR OF DAY
LEVIDAD TANK MODEL
                                                               1190
DESIGN LOAD
                                                               41.3
BYSTEM SUPPLY TEMPERATURE (DEG F)
                                                               45
SYSTEM RETURN TEMPERATURE (DEG F)
                                                               55
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL)
                                                               100
DEFAULT CHILLER ICEMAKING CAPACITY (% OF NOMINAL)
                                                               65
NUMBER OF COOLING HOURS
                                                               12
NUMBER OF ICE-MAKING HOURS
                                                               12
TOTAL COOLING LOAD (TONS-HRS)
                                                               473.1
 NOM .
         COOL
                  ICE
                                  ESTMID
                                            STRG
                                                    STRO
                                                             FEAK
                                                                       MIN
                                                                               MAX
 CHLR
         CAP
                  CAF
                            STRO
                                  TON
                                            INLET
                                                    DUT
                                                             STRG
                                                                        #
                                                                                #
 TONS
         TONS
                  TONS
                            DIV
                                  HOURS
                                            DEG F
                                                    DEG F
                                                             TONS
                                                                      TANKS
                                                                               TANKS
 32,28 :
         32.28
                  20.98
                            0.33
                                  128.30
                                            55. OO
                                                    45.00
                                                             41.30
                                                                       1.29
                                                                               1.28
 65.00
         45.00
                  42.25
                            0.31
                                  129.30
                                            55.00
                                                    45.00
                                                             41.30
                                                                       1.20
                                                                               3.27
```

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8 9 FLC	EM RE	PFLY T TURN T ) - DI	EMPER EMPER SCHAR	ATURE ATURE GE =	DESIGN FLOW # 45.0 # 55.0 105.3 # 5.9	NUI Des Ohr	EM ANAL OMBER OF SIGN LOARGE = ARGE =	CHILLI TANI DAD = 10	ER SI KS = 41	2 M	ODEL :			
HOU & TYP	LOAD E TONS	TONS	STRG TONS	TONE	TOTAL	TN-HRS/ TANK (	HARRE	TEMP	STRG	TEMP	RET TEMP	GPM PER TANK	100, 100, 10 per per	
1234567890112	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	42 42 42 42 18	35 36 37 13 0 0 0 0	17.3 17.2 18.4 6.0 0.0 0.0 0.0	238 274 311 347 360 360 360 360 360 360	119.2 137.1 155.3 173.7 180.0 180.0 180.0 180.0	6781.727 91.4777777777777777777	21.8 20.9 18.6 23.4 45.0 45.0 45.0 45.0	30.3 465.3 222.6 2.5 2.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4	30.3 29.6 29.6 27.5 26.3 **** 32.0 32.0 32.0 32.0	32.0 31.1 30.1 28.8 27.6 #### 47.5 51.5 52.8 53.2 53.5	52.7 52.7 52.7 52.7 52.7 52.7 0.0 0.0	69999444444444444444444444444444444444	
13 14 15 16 17 18 19 20 21 22 23 24	391 40 40 40 20 99 11 11 11 11 11	000043222244444444444444444444444444444	-59 -41	-16.4 -19.7 -20.2 -20.0 16.5 16.9 17.4 17.6	288 247 206 206 206 32 65 99 133 168	32.6 49.5 66.6	75.7 64.3 54.3 54.3 54.3 52.0 17.0 26.1 44.2	54.50 54.00 554.00 545.	45.0 45.0 45.0 45.0 31.9 31.8 31.7 31.2	33.7 34.6 35.5 32.0 32.0 31.9 31.8 31.7 31.5	54.5 55.0 54.8 53.4 50.6 34.0 33.7 33.4 33.4	20.7 24.1 25.8 26.7 0.0 52.7 52.7 52.7 52.7	2.2.4 **** 6.8 6.8	

# TANK DISCHARGE PROFILE

HOUR	TONS	INLET	OUTLET	FERCENT	OUT
E	PER	TEMP	T <b>EMP</b>	TANK	OF
TYPE	TANK	DEG.F	DEG.F	DISCH.	RANGE
13 F 14 F 15 F 16 F	16.4 19,7 20.6 20.1	52.9 54.5 55.0 54.8	45.0 45.0 45.0 45.0 45.0	######################################	2000年3月2日 日本の日本の日本の日本の日本の日本の日本の日本の日本の日本の日本の日本の日本の日

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- FLOW ANALYSIS -TON CHILLER - 2 MODEL STORAGE TANKS 1190

che ar	CHG GPM	<b>GPM/TANK</b>	dF(FSI)	AVG LCWT	MIN LCWT
3.0 4.0 5.0 6.0 7.0 8.0 9.0	359.1 269.3 215.5 179.6 153.9 134.7 119.7	179.6 134.7 107.7 69.8 77.0 67.3 59.9	**** **** 22.0 16.1 12.4 10.0 9.2 7.0	**** 23.3 22.6 22.0 21.3 20.6 19.9	#### #### 20.2 19.8 19.5 19.0 18.7
	DIS dT	DIS GFM	<b>GFM/TANK</b>	dP(P8I)	
	8.0 9.0 10.0 11.0 12.0 13.0 14.0	131.6 117.0 105.3 95.7 87.8 81.0 75.2 70.2	65.8 58.5 52.7 47.9 43.9 40.5 57.6 55.1	8.0 6.6 5.6 4.8 4.2 3.8 3.4	

# TYPICAL ICE STORAGE DESIGN

### I. Determine type of storage system.

The type of storage system, e.g., partial or full storage\*, chiller or ice priority, with or without eutectic salts, etc., is generally determined by economic and site considerations, such as utility rate structures, acceptable payback, retrofit vs. new construction and available space, to name a few.

Since chiller sizing and tank selection are straightforward for full storage, we will choose a partial storage, chiller priority system for our example.

### II. Establish a system configuration.

There are three basic system designs:

- 1. Series flow, storage upstream. (Figure 1.) Recoverable cooling storage is maximized but chiller inlet temperature is depressed. Control strategies and piping are simplified.
- 2. Series flow, chiller upstream. (Figure 2.) Chiller operates at a very high capacity and efficiency. Recoverable storage is decreased slightly. Also provides simplified control and piping.
- 3. Parallel flow. (Figure 3.) Both chiller and storage receive the benefit of high return temperature liquid. Chiller operates at high capacity and efficiency and recoverable storage is maximized. System pressure drop is reduced although controls and piping can be more complex than for series systems.

For our example, assume a series flow system, chiller upstream, with 45F supply and 60F return temperatures.

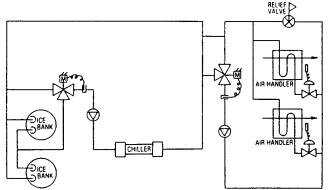


Figure 1. Series flow, storage upstream.

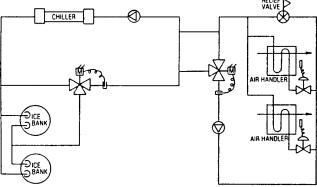


Figure 2. Series flow, chiller upstream.

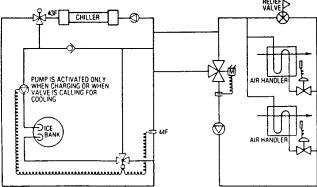


Figure 3. Parallel flow.

# III. Determine System Ton-Hours (STH).

Required ton-hours for the daily cooling period are calculated as follows:

Where Design Load = 1000 tons, Diversity = .85, and Number of Cooling Hours (occupied period + precool hours) = 10.

STH = Design Load x Diversity x Number of Cooling Hours

STH = 1000 tons x .85 x 10 hours = 8500 ton-hours

Alternatively, if hourly building loads are available from a building load profile, as in Figure 4, these can be summed up to give total System Ton-Hours.

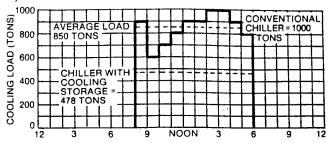


Figure 4. Building Load Profile.

### IV. Determine Nominal Chiller Size (NCS).

All chiller capacities are referenced to standard conditions. Therefore, the chiller tonnage calculated for this section is the required capacity at standard rating conditions, not ice making conditions. Basically, we are looking for the chiller whose total capacity—daytime cooling + ice making—will equal the total system ton-hours required.

- 1. From manufacturer's data, determine the chiller's capacity at ice making condition (usually about 25F LCWT and 31F RCWT) as a percentage of its standard or nominal capacity (CAP ice). A 1000-ton chiller that produces 650 tons at ice making conditions would be rated at .65. This is the figure we will use in the example.
- 2. Determine, from manufacturer's data, the chiller's capacity, as a percentage of its nominal capacity, for daytime cooling conditions (CAP <sub>OCC</sub>). Depending on system design, this number can be in excess of 1 or, for severe design conditions, may be slightly less than 1. For the example, a value of 1 will be used, which means that a 1000-ton nominal chiller will provide 1000 tons on a design day.
- Determine the number of hours available to make ice. This will be dependent on the building's unoccupied period, utility off-peak periods, on-peak/off-peak rate differentials, etc. We will assume 12 hours for ice making.
  - 4. Calculate minimum Nominal Chiller Size (NCS):

NCS = 
$$\frac{\text{System Ton-Hours}}{(\text{CAP}_{ice} \times \text{Icemaking Hrs.}) + (\text{CAP}_{occ} \times \text{Cooling Hrs.})}$$
NCS = 
$$\frac{8500 \text{ Ton-Hours}}{(.65 \times 12) + (1 \times 10)} = 477.5 \text{ Tons}$$

For Full Storage, use 0 for Cooling Hours in the equation above.

### V. Calculate the required number of Ice Banks.

The storage tanks must first be rated for the particular system conditions. This procedure is demonstrated on the bottom of page 3 in the "K-Factor" example for a Parallel Flow system. For our Series Flow example, we must calculate the temperature leaving the chiller and entering the tanks. At 1000 tons and a load  $\Delta t$  of 15 degrees (60F - 45F), the system flow for peak conditions will be:

GPM = 
$$\frac{\text{Tons x 25.5}}{\Delta t}$$
 =  $\frac{1000 \times 25.5}{15}$  = 1700

The chiller  $\Delta t$  will be:

$$\Delta t = \frac{\text{Tons x 25.5}}{\text{GPM}} = \frac{477.5 \times 25.5}{1700} = 7.16F$$

The temperature of the fluid entering the tanks will therefore be 60F - 7.16F = 52.84F. The leaving temperature will be 45F.

For 52.84 inlet and 45F outlet temperatures and a .85 diversity, the storage tanks (Model 1190) will deliver 86% (.86) of their nominal storage at a 19 ton rate.

The required storage is equal to the system ton-hours less the contribution of the chiller during the cooling period. The required

storage is then divided by the modified storage tank's capacity to achieve the proper number of tanks. Assume Model 1190 LEVLOAD Ice Banks, which are nominally rated for 190 ton-hours.

Number of Ice Banks = STH - (NCS x Cooling Hours)
Ton-Hours: Tank x K-Factor

Number of Ice Banks =  $\frac{8500 - (477.5 \times 10)}{190 \times 86}$  =22.8 (Use 23 tanks)

For Full Storage, use 0 for Cooling Hours in the equation above.

### VI. Check results.

1. Compare chiller capacity to load curve. These formulas assume that the chiller is operating at full load for the entire day. If the building load drops below chiller capacity during the cooling period, the chiller will unload and the total contribution of the chiller will be reduced. Under these circumstances the chiller will be undersized, although this is generally not the case. For the present example, the minimum building load is 600 tons (see Figure 4) and the calculated chiller size will be adequate.

2. Verify assumed charge temperatures. Using the charging flow rate and ice making chiller capacity, we can determine the actual required Average Charging Brine Temperature (ACBT), which is the same as the LCWT of the chiller, from the charge curves and compare to the assumption in Step IV. If the charging time is unusually short, you may find that the ACBT has been depressed and your assumption of chiller ice making capacity may have to be revised.

After correcting the pump capacity for the fluid conditions at ice making temperatures (let's say 1600 GPM for our system), a charging  $\Delta t$  can be calculated:

Chiller capacity = 477.5 x .65 = 310.4 tons

$$\Delta t = \frac{310.4 \times 25.5}{1600} = 5F$$

Divide the assumed chiller capacity by the number of tanks to calculate a tons/tank charge rate:

Tons/tank = 
$$\frac{310.4 \text{ tons}}{23 \text{ tanks}} = 13.5$$

From the Model 1190 Charge Curve (page 12) at 13.5 tons/tank and a 5F  $\Delta t$ , find an ACBT of 25 2F, which agrees with our original assumption. The Minimum Charging Brine Temperature (at full charge) is 22.3F.

3 Check for excessive discharge rates. The storage adjustment factor (K-Factor) is calculated to allow for normally encountered variations in discharge rate (peak loads). However, if unusually large variations in peak load occur for short periods, the storage outlet temperature may rise above design. (Consult Calmac in these circumstances.) In our example, we used a K-Factor of .86 and a 19 ton discharge rate. However, the peak discharge rate per tank of our system is 22.7 tons [ (1000 tons - 477.5 tons) ÷ 23 tanks] at 3:00 P.M. Since this is higher than 19 tons we must determine the average discharge rate *per tank* for the interval from peak to the final hour:

$$\frac{(1000 \text{ T-H} + 900 \text{ T-H} + 800 \text{ T-H}) - (477.5 \text{ Tons x 3 Hrs.})}{3 \text{ Hrs. x 23 Tanks}} = 18.4 \text{ Tons}$$

Since this is less than 19 tons, the design is valid.

 Check Ice Bank pressure drop. Maximum storage pressure drop is generally encountered during the charge period. Using the example:

$$GPM/tank = \frac{1600 GPM}{23 tanks} = 69.6$$

From the pressure drop curves (page 10), find storage pressure drop of 10.5 psi.

\*See Glossary on last page for explanations of unfamiliar terms.

## K-FACTOR EXAMPLE

Design Conditions:

· ·	
Occupied Hours	10
2. Precool Hours	2
3. Diversity (Average Load ÷ Peak Load)	.75
4. LEVLOAD Model	1100
5. Storage Inlet Temp. (F)	60
Maximum Temp. from Storage (F)	45

Cooling Hours = Occupied Hours + Precool Hours Adjusted Discharge Hours = Diversity x Cooling Hours Cooling Hours = 10 + 2 = 12 Hours of Discharge = .75 x 12 = 9.0

1. On the Model 1100 Performance Discharge Curve for a CONSTANT INLET TEMP. = 60F, locate Hours of Discharge (9.0)

along the horizontal axis.

- 2. Move vertically to the Blended Outlet Temperature point of 45 degrees. (Point A on Curve).
- 3. From Point A, move horizontally to the left to read the amount of total Ton-Hours available (90 TON-HOURS).
- 4. Move horizontally to the right to find the K-Factor which is used in our equations for designing the systems (.90).
- 5. Following a line up and to the right, read the Discharge Rate at which the tank was discharged for the 9 hours (10.0 TONS).
- 6. The flow rate for a one-tank system (GPM-sys) is calculated from the equation at bottom of Curve Sheet:

GPM = 25.5 x 10 tons/15F = 17

# Model 1100 EXAMPLE 60F

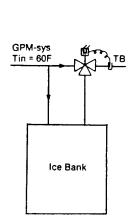
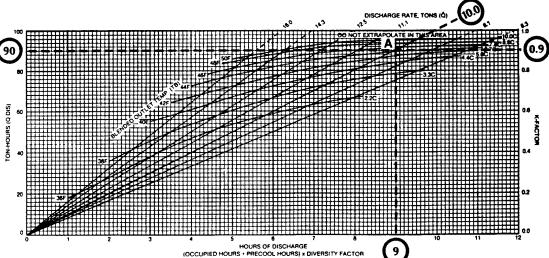


Figure 5. Blended outlet temperature



Mates  Unit MH/ Total Unit Cost Price  EA  EA  EA  EA  EA  EA  EA  EA  EA  E	CODE C DRAWING NO.	22-Apr-92
TON) 1 EA		SHT OF
No. Ol Unit   MH/   Total   Unit   MH/   Total   Unit   ESTIMATOR RMG	CHECKED BY CE.	
No. Of Muth Mrt Total Unit No. Of Units Meas Unit Hrs Price Cost Price Cost  2 EA	MATER	SHIPPING
Units Meas Unit Hrs Price Cost Price Cost  2 EA	Cuit	Unit Total
1 15%	- -	-
15%		
	-	
CONTINGENCY 15%	\$123	\$123.000
<b>▼LCL</b>		

# APPENDIX C-14.1 LOADING DOCK SEALS

LIFE CYCLE COST ANALYSIS SUMMARY STUDENT OF THE CYCLE COST ANALYSIS SUMMARY STUDENT OF THE CONSERVATION INVESTMENT PROGRAM (ECIP) LCC INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORT OF THE CONSERVATION NAME: ECO-14 LOADING DANALYSIS DATE: 07-17-92 ECONOMIC LIFE 15 YEARS PREPARED BY		
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ \$ -\$	101808. 5600. 6109. 0. 113517.
2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SA	\VINGS	
UNIT COST SAVINGS ANNUAL \$ DISCOUNT FUEL \$/MBTU(1) MBTU/YR(2) SAVINGS(3) FACTOR(4	l) SA	VINGS(5)
A. ELECT \$ 7.47 377. \$ 2820. 11.11 B. DIST \$ .00 0. \$ 0. 14.26 C. RESID \$ .00 0. \$ 0. 16.89 D. NAT G \$ 4.67 4234. \$ 19773. 14.45 E. COAL \$ .00 0. \$ 0. 11.21 F. TOTAL 4611. \$ 22593.	L 5 <del>9</del> 5	31334. 0. 0. 285717.
F. TOTAL 4611. \$ 22593.	\$	317051.
3. NON ENERGY SAVINGS(+) / COST(-)		
A. ANNUAL RECURRING (+/-) (1) DISCOUNT FACTOR (TABLE A) (2) DISCOUNTED SAVING/COST (3A X 3A1)	<b>\$</b> 9	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+31	Bd4)\$	0.
D. PROJECT NON ENERGY QUALIFICATION TEST  (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 104  A IF 3D1 IS = OR > 3C GO TO ITEM 4  B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)  C IF 3D1B IS = > 1 GO TO ITEM 4  D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		
4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LI		
5. TOTAL REF PERSONNELS PERSONNELS (PERSONNELS)		317051.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= (IF < 1 PROJECT DOES NOT QUALIFY)		
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4	5.02	

# LOADING DOCK SEALS SAMPLE CALCULATION, ECO #14 BUILDING 512

# Given:

Building 207 has 5 truck loading dock doors. Building 512 has 6 truck loading dock doors.

Gas Savings = 336 MBtu / 5 doors - from Bldg 207 simulation - from Bldg 207 simulation Electric Savings Factor = 8,778 kWh / 5 doors- from Bldg 207 simulation Demand Savings Factor = 0.0 kW- from utility rate analysis Gas Cost = \$4.67 / MBtu= \$0.0255 / kWhElectric Cost - from utility rate analysis - from utility rate analysis Demand Cost = \$8.85 / kW

# Peak Demand Savings:

= 0.0 kW

# **Annual Energy Savings:**

- Gas: ((336 MBtu / 5 doors) \* 6 doors) = 403 MBtu - Electric: ((8,778 KWh / 5 doors) \* 6 doors) = 10,534 kWh

# **Annual Cost Savings:**

 $(403 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (10,534 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$2,153 / \text{ yr}$ 

## **Estimated Construction Cost:**

\$1,616 / door (\$1,616 \* 6 doors) = \$9,696 \$9,696 + (\$9,696 \* .055 SIOH) + (\$9,696 \* .06 DESIGN) = \$10,811

# E M C ENGINEERS, INC. PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: LOADING DOCK SEALS

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE:

PRPARED BY: CHECKED BY: E.

SEALS.WK3 DENNIS JONES 07/22/92 #3105.000

			ENERGY		DISCOUNT		SAVINGS					
			COST		FACTOR		FACTOR					
INCREMEN	NCREMENTAL GAS COST	ST	\$4.67 MBt	MBtu	14.45 UPWG	JPWG	67.20	67.20 MBtu/door				
INCREMEN	NCREMENTAL ELECTRIC COST	IIC COST	\$0.0256 kWh	₩.	11.11	11.11 UPWE	1755.60	755.60 kWh/door				
ELECTRIC	ELECTRIC DEMAND CHARGE	MARGE	\$102.66 kW	<b>%</b>	10.59 UPW	JPW	0.00	0.00 kW/door				
ECONOMIC LIFE	CLIFE		15)	15 YRS								
	NO OF	ANNOAL	ANNOAL	ANNOAL	TOTAL	ANNUAL	ANNUAL	ANNUAL	TOTAL			
BAIL DING	BUILDING OVERHEAD	DEMAND	EL ECTRIC	NAT GAS	ENERGY	ENERGY	DEMAND	NON-ENE	ANNOAL	CONST.		SIMPLE
NIMBER	DOORS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	SIR	PAYBACK
		SX.	(KAI)	(MBILI)	(MBfr)	(8)	9	9	9	<b>(%)</b>		(XRS)
214	3	0	5.267	202	83	1,076	0	0	1,076	5,406	2.8	2.0
505	9	0	10.534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
905	9	0	10.534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
507	9	0	10.534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
208	9	0	10.534	403	439	2,153	o	0	2,153	10,811	2.8	2.0
209	9	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
510	9	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
511	9	O	10,534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
513		0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	2.0
514		0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
512		0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
T.W.W.		•	•	POOP	4 E4 4		C	V	20 RN2	113 516	28	5.0

		10 U				INVIIATION NO	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	
						DACA 21-	DACA 21-91-C-0097			DATE APR 92	Q	22-Apr-92	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	OS Study					X CODE A	CODEB	CODEC		DRAWING NO.	Ġ	SHT OF	
LOCATION 11. MCTHERSON & 11 GINETH						O				ESTIMATOR RMG	RMG	CHECKED BY CEL	日
	Qua	Quantity		LABOR	Ę.		EQUIPMENT	ENT	MATERIAL	RIAL	TOTAL	SHIPPING	g
LOADING DOCK SEALS	₽ 0.			Total	Ç		Chit		cni <b>t</b>			Unit	Total
TASK DESCRIPTION	Units	Meas	Unit	Hrs	Price	Cost	Price	Cost	Price	Cost		ž	₹
LOADING DOCK SEALS FOR	1												
OVERHEAD DOOR													
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1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1													i
The state of the s													
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									A. Carre				
SUBTOTAL													
OVERHEAD, BOND	15%												
PROFIT	10%												
COST SUB-TOTAL													
CONTINGENCY	15%												

APPENDIX C-14.2

INFRARED HEATERS

FIS	SCAL YEAR	1992 DISC	ST ANALYSIS SUN INVESTMENT FOR FT. GILLEM CA21-91-C-0097 CRETE PORTION CONTRACT FOR FOR FOR FOR FOR FOR FOR FOR FOR FOR	NAME: ECO-14	RADIANT HEA	T	CO15 .065 TY SURVEY
1.	INVESTMEN A. CONST B. SIOH C. DESIG D. SALVA E. TOTAL	T RUCTION COST N COST GE VALUE COS INVESTMENT	ST (1A + 1B + 10	c - 1D)		\$ \$ - \$	955110. 52531. 57307. 0. 1064948.
2.	ENERGY SAT	VINGS (+) / DATE ANNUAL	COST (-) SAVINGS, UNI	T COST & DISC	COUNTED SAVI	NGS	
	FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR (4)	DIS SAV	SCOUNTED JINGS (5)
	A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ 7.47 \$ .00 \$ .00 \$ 4.67 \$ .00	5761. 0. 0. 12860. 0.	\$ 43043. \$ 0. \$ 0. \$ 60056. \$ 0.	11.11 14.26 16.89 14.45 11.21		478205. 0. 0. 867812.
	F. TOTAL		18621.	<b>\$</b> 103099.		\$	1346017.
з.	NON ENERG	Y SAVINGS(+)	/ COST(-)				
	A. ANNUAL (1) D: (2) D:	RECURRING ( ISCOUNT FACT ISCOUNTED SA	(+/-) FOR (TABLE A) AVING/COST (3A	A X 3A1)	10.59	\$ \$	o. o.
			SCOUNTED SAV				
	(1) 2	5% MAX NON E A IF 3D1 IS B IF 3D1 IS C IF 3D1B IS	QUALIFICATION ENERGY CALC (2 = OR > 3C GO < 3C CALC S = > 1 GO TO S < 1 PROJECT	PF5 X .33) TO ITEM 4 SIR = (2F5+3I ITEM 4	01)/1E)		
4.	FIRST YEAR	R DOLLAR SAV	VINGS 2F3+3A+(	3B1D/(YRS ECC	NOMIC LIFE)	)\$	103099.
			SAVINGS (2F5+				1346017.
6.	DISCOUNTE:	D SAVINGS RA PROJECT DOES	ATIO S NOT QUALIFY)	(SIR)=(5 /	1E)= 1.2	6	
7.	SIMPLE PA	YBACK PERIOR	(ESTIMATED)	SPB=1E/4	10.3	3	

# RADIANT HEAT SAMPLE CALCULATION, ECO #14 BUILDING 512

# Given:

# Gas Savings

Analysis based on "Development of Radiant Heating Economic Evaluation Methods," see attached factors page C-14.2.3

Gas Savings Factor = 1,183 Mbtu per 149,300 sq. ft
= .00790 MBtu / sq. ft.

# **Electric Savings Factor**

Analysis based on computer simulation of building 207, fan electric use, see page C-20.2

Electric Savings Factor = 155,220 kWH per 149,300 sq. ft = 1.03965 kWH / sq. ft.

Demand Savings Factor = 0.0 kW

Gas Cost = \$4.67 / MBtu - from utility rate analysis
Electric Cost = \$0.0255 / kWh - from utility rate analysis
Demand Cost = \$8.85 / kW - from utility rate analysis

# Peak Demand Savings:

 $(120,327 \text{ ft}^2)^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

# **Annual Energy Savings:**

- Gas:  $(120,327 \text{ ft}^2)^*(0.0079 \text{ MBtu / ft}^2) = 953 \text{ MBtu}$ - Electric:  $(120,327 \text{ ft}^2)^*(1.03965 \text{ kWh / ft}^2) = 125,098 \text{ kWh}$ 

# **Annual Cost Savings:**

 $(953 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (125,098 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$8,200 / \text{ yr}$ 

### **Estimated Construction Cost:**

\$0.588 / sq. ft. (120,327 ft<sup>2</sup> \* (0.588) = \$70,786 \$70,786 + (70,786 \* .055 SIOH) + (70,786 \* .06 DESIGN) = \$78,926

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO - 14: RADIANT HEAT

CLIENT CONTRACT NO. DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE: FILE:

09/02/92 RADIANT.WK3 DENNIS JONES #3105.000

PRPARED BY: CHECKED BY:

							SIMPLE	PAYBACK	(YRS)	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
								SIR		1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
							CONST.	COST	(\$)	97,930	109,488	50,259	18,009	78,926	78,926	78,926	78,926	78,926	78,926	78,926	78,926	78,926	78,926	1,064,948
						TOTAL	ANNUAL	SAVINGS	(\$)	9,481	10,599	4,866	1,743	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	103,097
		MBtu/ft2	kWh/ft2	kW/ft2		ANNOAL	NON-ENE	SAVINGS	(\$)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAVINGS	FACTOR	0.00792 MBtu/ft2	1.03965 kWh/ft2	0.00000 kW/ft2		!		SAVINGS	(\$)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PWG	PWE	PW		ANNUAL	ENERGY	SAVINGS	(\$)	9,481	10,599	4,866	1,743	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	7,641	103,097
DISCOUNT	FACTOR	14.45 UPWG	11.11 UPWE	10.59 UPW		TOTAL	ENERGY	SAVINGS	(MBtu)	1,712	1,914	879	315	1,380	1,380	1,380	1,380	1,380	1,380	1,380	1,380	1,380	1,380	18,620
		ABtu	:Wh	W.	rrs	ANNUAL	NAT GAS	SAVINGS	(MBtu)	1,183	1,322	209	217	953	953	953	953	953	953	953	953	953	953	12,860
ENERGY	COST	\$4.67 MBtu	\$0.0255 kWh	\$102.66 kW	15 YRS	ANNUAL	ELECTRIC	SAVINGS	(kWH)	155,220	173,539	79,661	28,544	125,098	125,098	125,098	125,098	125,098	125,098	125,098	125,098	125,098	125,098	0 1,687,945
		ST	AIC COST	IARGE		ANNOAL	DEMAND	SAVINGS	(kW)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCREMENTAL GAS COST	INCREMENTAL ELECTRIC COST	<b>ELECTRIC DEMAND CHARGE</b>	LIFE		FLOOR	AREA	(ft2)	149,300	166,920	76,623	27,455	120,327	120,327	120,327	120,327	120,327	120,327	120,327	120,327	120,327	120,327	
		INCREMEN	INCREMEN	<b>ELECTRIC 1</b>	ECONOMIC LIFE		BUILDING FLOOR	NUMBER AREA		207	214	400	401	505	206	205	508	509	510	511	512	513	514	TOTAL

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

RADIANT.WK3 DENNIS JONES 09/02/92 #3105.000

EMC PROJECT:	DATE:	PHPARED BY:	CHECKED BY:
EMO	DAT	王	CHE

G207			
OPERATIVE TEMPERATURE	T0	65 F	
BUILDING LOAD COEFFICIENT	BLC	70,320 Btu/F/hr	
AVERAGE HEAT GAIN	Qg(G)	119,860 Btu/hr	
CONVENTIONAL SYSTEM EFFICIENCY	Ecc(CEC)	75%	
RADIANT EFFICIENCY	RAD	25%	
FLOOR AREA	ΑF	149,300 ft2	
RADIANT COMBUSTION EFFICIENCY	Ecr(CER)	85%	

					CONVENTIONAL SYSTEM	IAL SYSTEM		RADIANT SYSTEM	YSTEM			
	NUMBER	BASE-65	OUTSIDE		CORRECTED HEATING	HEATING		NDOON		CORRECTED	HEATING	HEATING
	5	DEGREE	AIR	o	DEGREE	ENERGY	RADIANT	AIR	ပ	DEGREE	ENERGY	ENERGY
MONTH	DAYS	DAYS	TEMP	FACTOR	DAYS	USAGE	FACTOR	۵.	FACTOR	DAYS	USAGE	SAVINGS
		(F-day)	Œ		(F-day) (MBtu)	(MBtu)		(E)		(F-day) (MBtu)	(MBtu)	(MBtu)
	EN		Tosa	C, Eq-13	DDm, Eq-12	L,Eq-14	M, Eq-17	M, Eq-17 Ta,Eq-16	C, Eq-13	C, Eq-13 DDm, Eq-12	L,Eq-14	[d]-[l]
₹	<u>@</u>	ටු	[0]	回	Ξ	<u></u> [5]	Ξ		Ξ	图		Σ
NAN	31	636	47	4	632	1,422	0.184	62	4	554	1,101	321
FEB	78	518	20	4	488		0.184	63	4	431		242
MAR	31	428	26	4	357	803	0.184	64	4	322	640	163
APR	30	147	65	4	8	182	0.184	65	4	88	176	9
MAY	3	25	73	5	0	0	0.184	29	S	0	0	0
NOS	99	0	81	5	0	0	0.184	89	3	0	0	0
JUL.	3	0	82	9	0	0	0.184	89	5	0	0	0
AUG	31	0	82	9	0	0	0.184	89	S	0	0	0
SEP	30	18	77	2	0	0	0.184	29	3	0	0	0
OCT	3	124	29	4	23	52	0.184	99	4	40	80	(28)
NOV	90	417	55	4	375	844	0.184	64	4	337	699	175
DEC	31	648	48	4	601	1,353	0.184	63	4	529	1,050	304
YEAR	365	2,961			2,557	5,753				2,302	4,571	1,183
		DDa										

Variable, Equation Column

	JOBEMC #3105.	000 Ft. McPherson	d/Gillem ESOS
E M C ENCINEEDS INC		OF	
E M C ENGINEERS, INC.  Denver • Colorado Springs • Atlanta • Germany	CALCULATED BY	CEL DATE	9/2/92
domany	CHECKED BY	DATE	
	POALE		
Column J: 4, Correction Factor, C, Column K: 554 Correct Degree Day 1	n 650F (last number in ure oF Equation 13, page C- base, DDm, Equation sumption, L, Equation Equation 17, page C- Ca, Equation 16, page Equation 13, page C- base, DDm, Equation sumption, L, Equation	14.2.5 12, page C-14.2.5 14, page C-14.2.5 14.2.7 C-14.2.6 14.2.5 12, page C-14.2.5	a)
C, Eq-13 [E] 339*(0.00387*\$DDA-2.77E-07*\$DDA^2)*@EXP(-((\$TO-\$G/\$B	47   BLC-D26+20)/16.23) ^ 0.1)		
	•		
DDm, Eq-12		L,Eq-14	
[F]		[Ġ]	
MAX(\$B26*(\$TO-\$G/\$BLC-\$D26+E26),0)	+\$BLC*F26*24/\$C	EC/1000000	
M, Eq-17 [H]	Ta,Eq-16	rii)	-
\$RAD/\$AF/1.22*(0.35+0.35*0.64/0.58)*\$BLC/\$CER	+\$TO-(H26/(H26	+1))*(\$TO-D26-\$G/\$BLC)	)
<b>~</b>			
C, Eq-13 [J]			DDm, Eq-12
[0] 339*(0.00387*\$DDA-2.77E-07*\$DDA^2)*@EXP(-((I26-\$G/\$B	BLC-D26+20y16.23) ^ 0.1)	@MAX(\$B26*(126-\$G/\$B	[K] LC-\$D26+J26\0)
	, ,,	1 2 = (+=== ( .	+,
L,Eq-14	[G]-[L]		
[L]	[M]	C.14.2.3A	
BLC*K26*24/\$CER/1000000	+G26-L26		

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

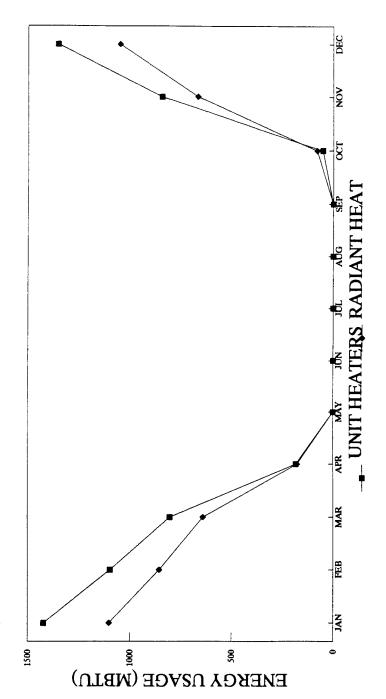
CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE:

FILE:

PRPARED BY: CHECKED BY:

09/02/92 RADIANT.WK3 DENNIS JONES #3105.000



# RADIANT HEAT HEAT LOADS

			INTERNAL	WEEKDAY	WEEKEND	WEEKLY
	WEEKDAY	WEEKEND	PEAK	HOURLY	HOURLY	AVERAGE
HOUR	PROFILE	PROFILE	LOAD	LOAD	LOAD	HOURLY
1	0.05	0.05	375332	18767	18767	INTERNAL
2	0.05	0.05	375332	18767	18767	LOADS
3	0.05	0.05	375332	18767	18767	
4	0.05	0.05	375332	18767	18767	
5	0.05	0.05	375332	18767	18767	
6	0.05	0.05	375332	18767	18767	
7	0.05	0.05	375332	18767	18767	
8	0.8	0.05	375332	300266	18767	
9	1	0.05	375332	375332	18767	
10	1	0.05	375332	375332	18767	
11	1	0.05	375332	375332	18767	
12	0.8	0.05	375332	300266	18767	
13	1	0.05	375332	375332	18767	
14	1	0.05	375332	375332	18767	
15	1	0.05	375332	375332	18767	
16	0.8	0.05	375332	300266	18767	
17	0.8	0.05	375332	300266	18767	
18	0.4	0.05	375332	150133	18767	
19	0.05	0.05	375332	18767	18767	
20	0.05	0.05	375332	18767	18767	
21	0.05	0.05	375332	18767	18767	
22	0.05	0.05	375332	18767	18767	
23	0.05	0.05	375332	18767	18767	
24	0.05	0.05	375332	18767	18767	
AVERAGE				160298	18767	119860

SEE COMPUTER SIMULATION OF BLDG 207 FOR PEAK LOAD AND LOAD PROFILE

BUILDING LOAD COEFICENT 0.471 Btu/sq.ft./hr/oF x 149300 sq.ft 70320 SEE COMPUTER SIMULATION OF BLDG 207 FOR BLDG HEAT LOSS COEF.

# **Energy Consumption Calculations**

The chief characteristic of radiant heating systems which results in energy savings is the reduction in room air temperatures and a corresponding reduction in envelope heat loss. Additional energy savings are also often the result of an increase in combustion efficiency over conventional heating equipment efficiencies. A simple means for determining heating loads is the variable degree day method [Ref. 8]. The Variable Base Degree Day method was selected due to its simplicity and its compatibility with the mathematical model. The Bin method was also considered, but was rejected since part-load efficiencies for radiant equipment were not available. The only advantage of the Bin method was its ability to consider part-load efficiencies.

Monthly values of degree days at a base temperature of 65°F (18°C) are tabulated for many locations all over the world [Ref. 5, 6]. The base 65°F (18°C) temperature may be corrected to other bases by the following formula [Ref. 4]:

$$DDm = Nm (t_b - t_{OSA} + C) , \qquad (12)$$

where

DDm = degree days at the new base temperature,

Nm = number of days in the month,

t<sub>b</sub> = new base temperature,

t<sub>osa</sub> = average outside air temperature,

C = correction factor.

The correction factor (C) is given by:

$$C = 1.339(0.00387 DDa - 0.277 \times 10^{-6}DDa^{2})$$

$$x \exp - [(t_b - t_{OSA} + 20^{\circ}F) / 16.23]^2,$$
 (13)

where

DDa = annual base 65°F degree days.

Monthly energy consumption (L) for space heating is:

$$L = BLC \times DDm / E_{cc}, (14)$$

where

BLC = building loss coefficient,

 $E_{\infty}$  = combustion efficiency of a conventional system.

The BLC is the sum of the individual heat loss factors (component area divided by thermal resistance) for building components plus infiltration/ventilation loads. The following components are generally included:

- Walls
- Ceiling
- Windows
- Doors
- Floor perimeter
- Infiltration/ventilation.

Base temperature (t<sub>b</sub>) is calculated as follows:

$$t_b = t_a - Q_0/UA , \qquad (15)$$

where Q<sub>g</sub> is the energy generated by lights, equipment, occupants, and solar gains.

The heating load for the conventional heating system is then calculated using equation (14) in which degree days is based on the base temperature from equation (15). For conventionally heated buildings, the indoor air temperature (t<sub>a</sub>) in equation (15) is equal to the thermostat setpoint.

# **Radiant Heat Evaluation**

The previous study used a computer model to iteratively solve equations (7) through (11) in the order presented. In order to make the model more efficient and to develop nomographs, it was necessary to develop a single equation for performance.

For any given application, equations (7) through (11) will have five unknowns:

ERF<sub>c</sub> = radiant flux from ceiling,

 $ERF_F = radiant flux from floor,$ 

t<sub>a</sub> = indoor air temperature,

t<sub>i</sub> = floor temperature,

 $Q_R$  = system energy input.

Solving the five equations simultaneously results in the following expression for indoor air temperature (t<sub>a</sub>):

$$t_a = t_o - [M/(M+1)](t_o - t_{OSA} - Q_G/BLC)$$
, (16)

where

desired operative temperature,

M = radiant factor,

 $t_{OSA}$  = outside air temperature,

Q<sub>a</sub> = internal generated hear from lights, people, and equipment.

BLC = building envelope heat loss factor.

The radiant factor (M) is given by:

$$M = \frac{E_R}{A_F(h_r + h_c)} \begin{pmatrix} F_C + F_F h_r \\ \hline h_t \end{pmatrix} \frac{BLC}{E_{CR}}$$

where

 $E_R$  = radiant efficiency.

 $A_F$  = floor area,

h, = total heat transfer coefficient from floor to room,

F<sub>c</sub> = ceiling angle factor,

 $F_F$  = floor angle factor,

h, = radiative exchange coefficient of human body,

 $E_{cr}$  = combustion efficiency.

Once indoor air temperature (t<sub>a</sub>) is calculated, the remaining unknowns may be calculated from the equations (7) through (10).

The heating load for the radiantly heated building is calculated in two parts; for the floor and for the rest of the building. The floor in a radiantly heated building is maintained at a temperature higher than inside air temperature and thus has a proportionally higher heat loss. For the floor, the base temperature of equation (15) is set at the monthly floor temperature predicted for the radiant system. Heating load of the floor is then the corrected degree days based on floor temperature times the floor loss component of BLC divided by the combustion efficiency.

For the non-floor heating load, the base temperature is calculated from the indoor air temperature predicted for the radiantly heated space. The heating load of the non-floor components is then the corrected degree days times the non-floor components of the

BLC divided by the combustion efficiency. The total radiant heating load is then the sum of floor and non-floor heating loads.

For further information, the following references may be useful.

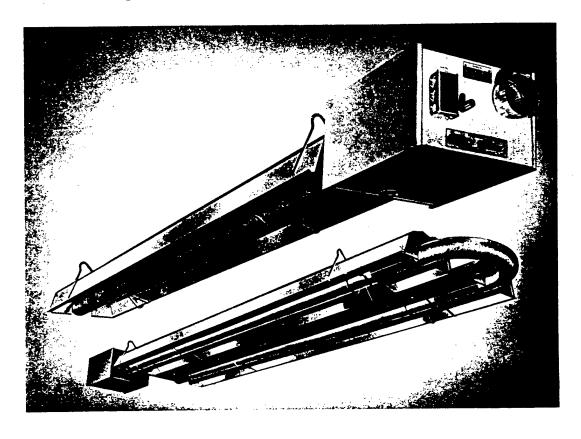
- American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Infrared Radiant Heating," <u>ASHRAE Handbook</u>, 1987 Systems and Applications Volume, Chapter 16, Atlanta, Georgia.
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- 7. Wilson, T., and R. Belske, "Movable Insulation Systems," <u>ASHRAE Journal</u>, pp. 26-31, February 1987.
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H. McPherson & F. Gillem  V. F. McPherson & F. Gillem  Ouerrity  Gas—Fired Redient Heater  Ouerrity  Ouerrity  Ouerrity  Ouerrity  Units  No. Off  Units  Units  Discount Heater  Units  Discount Heat	COST ESTIMATE ANALYSIS	ANALY	SIS				INVITATION N	INVITATION NO./CONTRACT NO.	ó	-	EFFECTIVE PRICING	AICING .	DATE PREPARED	Œ
ESOS Shady   Courty			  - 			_	DACA 21-	91-C-0097			DATE APR 92	21	15-Apr-92	
1	1	Study					X CODE A		CODEC		DPAWING NO			
Charmitry   Char	-						OTHER				ESTIMATOR	₩G	CHECKEDBY	
No. Cutaming   Mark   Total   Unit					Cavi			Mai	F	MATE	Z.	TOTAL	SHIPPIN	ā
1996   Cost   Price   Price   Cost   Price		S C	1	Ì		- 1		Linit		Ę			Unit	Total
Marie   Mari	ECO 14 - Gas - Fired Rediant Heater	5 4			<u> </u>	Price	Cost	Price	So	Price	Cost		¥	₹
1 (inc. piping, wiring, controls 340, BOND 10% 10% 10% 10% 10% 10% 10% 10% 10% 10%	TASK DESCRIPTION	5	Meas	$\perp$	0	3	53			\$10.00	\$10.00	\$10.00		
15% 15% 15% 10% 10% 10% 10% 10% 10% 10% 10% 10% 10	HEATER, inc. piping, wiring, controls	-	Z Z									\$10.00		
SAD BOND 1956  SUB-TOTAL GENCY  GENCY	SUBTOTAL											5		
UBB-TOTAL 15% GENCY  15%  16%  16%  16%  16%  16%  16%  16%	OVERHEAD, BOND	15%										3		L
0ebc/r  0ebc/r  0ebc/r  15%	PROFIT	10%										B.1.		
	COST SUB-TOTAL											\$1250		
	CONTINGENCY	15%										8 8		
	TOTAL											\$14.38		
														-
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Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & F.C. Sillem ESOS Study   Section & Sect	DACA 21 - 91 - C - 0097     X	DE C	DATE APR 92 DRAWING NO. BESTIMATOR RMG MATERIAL Trice Cost DO0.00 \$20,000.00 \$24,000 \$15.55 \$5.17 \$6.34.00 \$15.00 \$15.50 \$5.20 \$151.00 \$15.50 \$5.20 \$124.00 \$15.50 \$5.20 \$5.247.00 \$15.50 \$5.20 \$5.000.00 \$24.50 \$5.20 \$5.000.00 \$24.50 \$5.20 \$5.000.00 \$24.50 \$5.20 \$5.000.00 \$24.50 \$5.20 \$5.000.00 \$24.50	385.76 385.76 385.76 385.76 385.76 385.76 385.76 375.18	SHT OF CHECKED BY CB. SHIPPING Unit Total Wft Wft
Content   Cont	Cost Price \$4,176.00 \$196.69 \$136.69 \$136.69 \$136.69 \$256.82 \$	DE C \$30 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1 \$1		31AL 17600 615.36 3347.69 2276.01 385.76 5503.82 5503.82 100335	SHT OF SHIPPING CE SHIPPING K
Authority  No. Of Unit MH/I Total Unit Total Unit Hrs Price Cost Units MH/I Total Unit Hrs Price Cost Unit Hrs 10 200 \$20.88 \$4,176.00  200 LF 0.235 47 \$20.88 \$4,176.00  200 LF 0.035 77 \$20.88 \$4,176.00  200 LF 0.036 728 \$20.88 \$196.69  200 LF 0.013 12.7 \$20.88 \$196.69  200 LF 0.013 12.7 \$20.88 \$256.75  200 LF 0.013 12.7 \$20.88 \$256.76  200 LF 0.013 12.7 \$256.88  200 LF 0.013 12.7 \$256.	Cost Pri \$4,176.00 \$981.36 \$196.69 \$152.01 \$6,305.76 \$256.82 \$256.82 \$256.82 \$18,100.35	Sost (\$1.00)		01AL 176.00 615.36 3347.69 385.76 385.76 385.76 100.35	SHIPPING Unit Wt
Mo	\$4,176.00 \$4,176.00 \$981.36 \$196.69 \$196.69 \$152.01 \$6,305.76 \$256.82 \$256.82 \$256.82 \$18,100.35	20st P 81,0		27AL 176.00 615.36 347.69 385.76 385.76 385.76 385.76 385.76 385.76 375.18	SHIPPING Chit
Main   Main	\$4,176.00 \$4,176.00 \$981.36 \$196.69 \$196.69 \$152.01 \$6,305.76 \$256.82 \$256.82 \$256.82 \$18,100.35	20st P 81,0	# # # # # # # # # # # # # # # # # # #	69	
No. Of   Unit   MH/   Total   Unit   Unit   Unit   Unit   MH/   Total   Unit   Unit   Unit   MH/   Total   Unit   Unit   Unit   MH/   Total   Unit	\$4,176.00 \$4,176.00 \$981.36 \$196.69 \$1152.01 \$6,305.76 \$256.82 \$256.82 \$256.82 \$18,100.35	- IS	3, 3, 5,	Š ↔	
Name	\$4,176.00 \$981.36 \$196.69 \$196.69 \$196.69 \$152.01 \$6,305.76 \$256.82 \$256.82 \$256.82 \$256.18	<u> </u>	\$ 8	N S S S S S S S S S S S S S S S S S S S	*
Fig. NBH   20   EA   10   200   \$20.86   43   \$20.86   44   \$20.86   \$20.86   44   \$20.86	<del>й</del> <del>ё</del>	\$1,000 00 \$3.17 \$6.20 \$12.33 \$12.33 \$0.11	0 9 9	Ž &	
200   LF   0.235   47   \$20.88    3,4*   20   EA   0.471   9.42   \$20.88    20   EA   0.471   9.42   \$20.88    20   EA   0.364   7.28   \$20.88    20   EA   0.364   7.28   \$20.88    20   EA   0.151   302   \$20.88    20   EA   0.015   12.7   \$20.88    30   MSF   2.85   855   \$21.17   \$\$  30   MSF   2.85   855   \$21.17   \$\$  31   A   A   A   A    32   A   A   A    33   A   A    34   A   A    34   A   A    35   A    36   A    37   A    38   A    39   A    30    30   A    30    30   A    30   A	<del>-</del>	\$3.17 \$6.16 \$7.56 \$1.56 \$11.23 \$12.33 \$12.33 \$20.00	9 9	₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩	
3,4* 20 EA 0.471 9.42 \$20.88	φ <del>"</del>	\$6.16 \$6.28 \$1.56 \$11.23 \$12.33 \$20.00	9 9	<b>\$</b>	
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2000 LF 0.151 302 \$20.88 \$20.88 \$20.88 \$20.88 \$20.88 \$20.88 \$20.89 \$20.89 \$20.89 \$20.80 \$20.8	<b>ઝ</b>	\$6.2 \$11.5 \$12.30 \$0.11		\$276.01 \$9,385.76 \$503.82 \$375.18 \$24,100.35	
2000 LF 0.151 302 \$20.88	<del>\$</del>	\$1.5x \$12.33 \$0.11 \$20.00		\$9,385.76 \$503.82 \$375.18 \$24,100.35	
20 EA 0615 12.3 \$20.88 1000 LF 0.013 12.7 \$20.88 300 MSF 2.85 855 \$21.17 \$ 301 MSF 2.85 855 \$21.17 \$ 402 MSF 2.85 855 \$21.17 \$ 403 MSF 2.85 855 \$21.17 \$ 404 MSF 2.85 855 \$21.17 \$ 404 MSF 2.85 855 \$21.17 \$ 404 MSF 2.85 855 \$21.17 \$ 404 MSF 2.85 855 \$21.17 \$ 405 MSF 2.85 855 \$21.17 \$ 405 MSF 2.85 855 \$21.17 \$ 407 MSF 2.85 855 \$ 407	5	\$12.3 \$0.11 \$20.00		\$503.82 \$375.18 \$24,100.35	
1000 LF 0.013 12.7 \$20.88 300 MSF 2.85 855 \$21.17 \$  1000 LF 0.013 12.7 \$20.88	<del>5</del>	\$20.00		\$375.18 \$24,100.35	
300 MSF 2.85 855 \$21.17 \$  100		\$20.0		\$24,100.35	
15%					
TTAL  EAD, BOND  10%					
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FAD, BOND 15% 15%					
TAL \$ EAD, BOND 15% 10%					
EAD, BOND 15% 10%			\$30.468.00	\$61,098.86	
EAD, BOND 15% 10%	\$30,620,000		\$4 570 20	_	
10%	20.480.44		42 046 90	1	
	\$3,063.09		\$3,040.00	`	
COST SUB-TOTAL	\$38,288.57		\$38,085.00	-	
CONTINGENCY 15% \$5,743.29	\$5,743.29		\$5,712.75		
TOTAL	\$44 031 B5		\$43,797.75	\$87,829.60	



## Cost-Saving, Low-Intensity Infrared Unitary Heaters



## Roberts-Gordon, Inc.

Energy Efficient Comfort.

## VANTAGE II Unitary Heaters Lower Fuel Costs and Raise Comfort Levels.

## **Demonstrated Savings**

Modern gas combustion technology combined with the principles of infrared energy enable VANTAGE II heaters to reduce fuel costs substantially while improving comfort conditions. Users report heating bills cut by up to 50% and more!

# Low Cost...Easy to Install and Maintain

The VANTAGE II models are low-cost, field-assembled infrared heaters that are easy to install and require only minimal maintenance. They are designed to provide years of economical operation and trouble-free service.

## Versatility

VANTAGE II heaters can be installed separately or in combination to fit any floor plan. Straight, L- and U-tube configurations are available. Tube lengths are offered from 10 through 60 feet. Ideal for large areas as well as hard-to-heat spaces!

## Reliability and Expertise

Roberts-Gordon pioneered low-intensity infrared heating systems in 1962 and manufactures the broadest line of low-intensity heating equipment in North America. Backed by a limited three-year warranty, each VANTAGE II unitary heater is built to uphold the well-established Roberts-Gordon standards of engineering excellence, efficiency and reliability.



## **Applications Include:**

- Automotive Facilities
- Warehouses
- Manufacturing Facilities

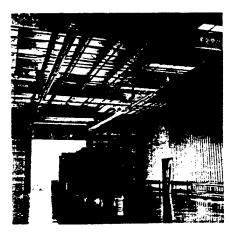
Clean, quiet, draft-free Vantage radiant heat is ideal for this automotive service facility. Unlike forced-air unit heaters, Vantage does not spread dirt, grit or dust.

- Fire Stations
- Agricultural Buildings
- Recreational Facilities



Vantage unitary heaters are available in a variety of lengths, shapes and configurations to fit any floor plan. Two straight-tube models are shown above in a car dealership.

- Machine Shops
- Aircraft Hangars
- Vehicle Maintenance Buildings



Floors are kept warm by Vantage infrared energy and act as heat reservoirs to provide rapid heat recovery after bay doors are closed in this warehouse/ shipping area.



#### Features:

- Extensive use of corrosion-resistant materials.
- Weight-saving construction to ease installation.
- Forced draft design eliminates the need for a heat-siphoning draft hood.
- Quiet operation.
- 10 through 60 foot tube lengths.
- Three-year limited warranty on all components.
- A.G.A. design certified.

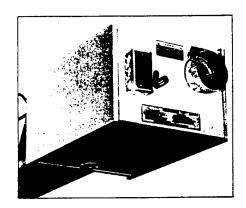
**Burner Box:** 

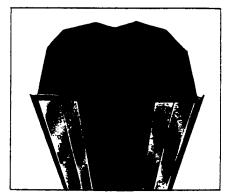
- 40,000; 60,000; 80,000; 100,000; 125,000 and 150,000 BTU/Hr. models available.
- Natural gas and L.P. models available.
- Moisture-resistant design.
- Stainless steel burner cup.
- Outside air adapter standard.
- Hot surface ignition.
- Three-try ignition module.
- Door interlock safety switch.
- All components easily accessed.
- Electrostatically applied paint.
- Durable spot welded construction.
- Mica flame observation window.
- Balanced air rotor.
- Stainless steel flex gas line and high pressure gas cock included.

**Tube and Reflector:** 

- 4" diameter 16 gauge tubing.
- Quick assembly couplings.
- Deep-dish aluminum reflectors maximize energy reflection, beaming virtually all of the radiant heat downward.
- Reflectors can be tilted 45° to direct heat where needed.
- Entire U-tube heater also can be tilted 45°.
- End caps included.
- Nickel plated hangers.
- Chrome plated hardware.
- Flue connector included.
- 180° U-package (9" radius) option.
- 90° L-package option.
- Decorative grille option.
- Side reflector option.

"The VANTAGE II heater utilizes design concepts and engineering principles proven by more than 25 years of infrared heating experience."





## Architectural/Engineering Short Form Specifications VANTAGE II CTH2 SERIES

Gas-fired, vented, infrared heaters shall be furnished and installed in accordance with governing codes and as shown per building drawing(s) as described below.

Heaters shall be VANTAGE II, model number CTH2-\_\_\_\_\_\_,\_\_\_\_BTU/Hr. as manufactured by Roberts-Gordon, Inc., Buffalo, New York.

Heaters shall be equipped with a direct sense silicon-carbide hot surface ignition control system with 100% shut-offignition device. Power supplied to each heater shall be 120V, 60Hz, 1 $\phi$ . Heater to be equipped with totally enclosed motor with thermal overload motor protection, balanced air rotor, combustion air proving safety pressure switch, stainless steel burnerhead, combustion chamber equipped with sight glass for visual inspection of igniter element and burner flame. Air intake collar standard. Radiant tube assembly to be 4" diameter, aluminized steel first 10 feet. Hot rolled steel remainder of unit. (Or at customer option, all aluminized steel for entire tube length.) Reflector to be of aluminum material and designed to direct all radiant output below horizontal centerline of radiant tube. Heaters shall be vented in accordance with manufacturer's recommendations and ANSI Z-223.1 National Fuel Gas Code. Heaters shall be so designed to operate without requiring heater modifications or adjustments on \_\_\_\_\_\_\_ gas having a net heating value of \_\_\_\_\_\_\_ BTU per cubic foot and a specific gravity of \_\_\_\_\_\_\_\_

Heaters shall be Design Certified by the American Gas Association (A.G.A.). Supplier shall provide a manufacturer's written warranty covering all components for a period of three (3) years.

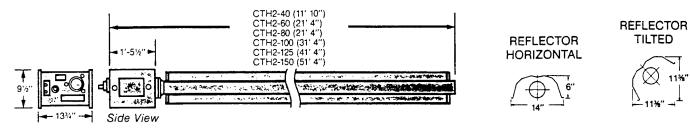


FLUE CONNECTION	GAS CONNECTION	ELECTRICAL RATING	TUBE	IGNITION SYSTEM	MIN. GAS INLET PRES.
4" (O.D.)	1/2" NPT	120VAC, 60Hz. 1.0 amp run 5.0 amp start	4"	Hot surface (Three-try)	Nat. 4.6" W.C. L.P. 11.0" W.C.

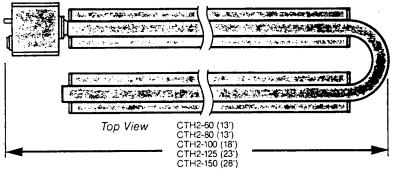
MODEL	BTU/Hr. (Natural Gas or LP.)	SHIPPING WEIGHT
CTH2-40	40,000	95 lbs.
CTH2-60	60,000	130 lbs.
CTH2-80	80,000	130 lbs.

MODEL	BTU/Hr. (Natural Gas or LP.)	SHIPPING WEIGHT
CTH2-100	100,000	165 lbs.
CTH2-125	125,000	200 lbs.
CTH2-150	150,000	235 lbs.

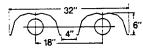
#### **DIMENSIONS (Standard Models) STRAIGHT**



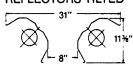


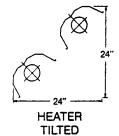






#### **REFLECTORS TILTED**





TILTED

#### **CLEARANCES TO COMBUSTIBLES\***

in the second second			CTH2-4	0 3	Sa	CTH2-6	0	1	CTH2-	0		CTH2-1	00		CTH2-1	25		CTH2	50 <b>5</b>
Configuration	Reflector	Тор	Below	Side	Тор	Below	Side	Тор	Below	Side §	Тор	Below	Side	Top	Below	Side	Ţõõ	Below	Side
Straight	Horizontal	4"	50"	22"	4"	60	30"	4"	63"	33"	4"	68"	35"	4"	74"	41"	4"	77"	45"
Straight	:ুTilted 🚈	4"	45"	4"/42"	4"	54"	4"/50"	4"	60"	4"/56"	6"	68"	4"/60"	6"	72"	4"/65"	8"	78"	4"/70"
- U-Tube	Horizontal	_	_	_	4"	60"	25"/30"	4"	66"	32"/33"	4"	73"	34"/35"	4"	76"	38"/41"	4"	81″	42"/45"
U-Tube	بِيِّنَةٍ Tilted	_	_	-	4"	54"	18"/50"	4"	60"	18"/56"	6"	68"	18"/60"	6"	72"	18"/66"	8"	78"	18"/70"

Configuration	Heater	Тор	Below	Side	Тор	Below	Side	Тор	Below	Side	Тор	Below	Side	Тор	Below	₃ Side ?	Top	Below	(Side
U-Tube	Tilted	_	-	_	4"	54"	4"/38"	4"	60"	4"/42"	4"	~	4"/48"	4"	72"	57"	4"	78"	4"/62"

<sup>\*</sup>See installation manual for complete information.



#### Roberts-Gordon, Inc.

Subsidiary of A.J. Industries, Inc.

P.O. Box 44 • Buffalo, NY 14240-0044 Phone: (716) 852-4400 • Fax: (716) 852-0854



CALL TOLL FREE: 1-800-828-7450 IN NEW YORK: 1-800-221-0955

# APPENDIX C-15 SEPARATE SWITCHES TO CONTROL LIGHTING

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORT FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 SEPARATE SWIT ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY:	: 3 CUNITY S ICHES FO	SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 2 \$ 5 -\$ 5	26971. 1484. 1619. 0. 30074.
<pre>2. ENERGY SAVINGS (+) / COST (-)    ANALYSIS DATE ANNUAL SAVINGS, UNIT COST &amp; DISCOUNTED SAVI</pre>		
UNIT COST SAVINGS ANNUAL \$ DISCOUNT FUEL \$/MBTU(1) MBTU/YR(2) SAVINGS(3) FACTOR(4)	DISCOU	JNTED 3S (5)
A. ELECT \$ 7.47 163. \$ 1218. 15.61 B. DIST \$ .00 0. \$ 0. 21.66 C. RESID \$ .00 0. \$ 0. 26.51 D. NAT G \$ 4.67 -18. \$ -82. 23.77 E. COAL \$ .00 0. \$ 0. 16.06	:	19014. 0. 0. -1954. 0.
F. TOTAL 145. \$ 1136.	\$	17060.
3. NON ENERGY SAVINGS(+) / COST(-)		
A. ANNUAL RECURRING (+/-) (1) DISCOUNT FACTOR (TABLE A) 14.53		1141. 16579.
(1) DISCOUNT FACTOR (TABLE A) (2) DISCOUNTED SAVING/COST (3A X 3A1)	•	
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4  D. PROJECT NON ENERGY QUALIFICATION TEST (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 56:  A IF 3D1 IS = OR > 3C GO TO ITEM 4  B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)  C IF 3D1B IS = > 1 GO TO ITEM 4  D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	30.	16579.
4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE	))\$	2277.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$	33639.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1. (IF < 1 PROJECT DOES NOT QUALIFY)  *** Project does not qualify for ECIP funding; 4,5,6 for informations.		nly.
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.	21	

## SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15 BUILDING 184, ROOM 6

#### Given:

# of Fixtures = 2 fixture - from survey notes Fixture Type - from survey notes = 4x2 4-lamp fluorescent Watts / Fixture = 155 W / fixture - from manufacturer info Percent Lighting Savings = 19% - average for all bldgs = 3,393 hrs / yrHours On / Year = 3,393 hrs / yr = 5.4E-4 MBtu / kWh - from bldg occupancy Gas Increase Factor - from computer simulation Electric Savings Factor = 0.17 kWh / kWh - from computer simulation - from utility rate analysis Gas Cost = \$4.67 / MBtu - from utility rate analysis **Electric Cost** = \$0.0255 / kWh- from utility rate analysis = \$8.85 / kW Demand Cost

#### Existing Lighting Demand:

 $(2 \text{ fixtures})^*(155 \text{ W} / \text{fixture}) = 0.31 \text{ kW}$ 

#### Peak Demand Savings:

$$(0.31 \text{ kW})^*(0.19) = 0.06 \text{ kW}$$

#### **Annual Energy Savings:**

#### Electric:

Lighting:

 $(0.06 \text{ kW})^*(3,393 \text{ hrs}/\text{yr}) = 200 \text{ kWh}/\text{yr}$ 

Cooling:

 $(200 \text{ kWh})^*(0.17 \text{ kWh} / \text{kWh}) = 34 \text{ kWh} / \text{yr}$ 

Total:

200 + 34 kWh / yr = 234 kWh / yr

Gas:

 $(200 \text{ kWh /yr})^*(5.4\text{E-4 MBtu / kWh}) = 0.1 \text{ MBtu / yr}$ 

#### **Annual Cost Savings:**

$$(234 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.06 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) - (0.1 \text{ MBtu})^*(\$4.67 / \text{MBtu}) = \$12.08 / \text{yr}$$

#### **Estimated Construction Cost:**

\$65.11 / wall sensor - from engineer's cost estimate

$$($65.11 / ea)*(1 sensor) = $65$$

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:

DATE: FILE: PRPARED BY:

CHECKED BY:

#3105.000 07/20/92 MLITSIR.WK3 CAMERAN DIBAI

> 23.77 UPWG 15.61 UPWE 14.53 UPW **FACTOR** DISCOUNT \$102.66 kW 25 YRS \$4.67 MBtu \$0.0255 kWh COST ENERGY **ESTIMATED 8760 HOURS OF LIGHTING PER YEAR** INCREMENTAL ELECTRIC COST **ELECTRIC DEMAND CHARGE NCREMENTAL GAS COST ECONOMIC LIFE**

	ANNUAL	ANNUAL	ANNOAL	TOTAL	ANNUAL	ANNUAL	ANNUAL	TOTAL			
	DEMAND	ELECTRIC	NAT GAS	ENERGY	ENERGY	DEMAND	NON-ENER	ANNUAL	CONST.		SIMPLE
	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	SIR	PAYBACK
BLDG	(kW)	(KWH)	(MBtu)	(MBtu)	(\$)	(\$)	(%)	(\$)	(\$)		(YRS)
103	0.304	1,702.0	(0.58)	2	\$41	\$31	\$0	\$72	\$436	2.4	6.1
213	2.3	9,316.4	(1.72)	30	\$230	\$236	<b>€</b>	\$466	\$3,349	2.1	7.2
935	1.23	6,193.0	(5.80)	15	\$131	\$126	\$0	\$257	\$3,465	1.1	13.5
101	7.28	30,555.0	(9.48)	95	\$735	\$747	S\$	\$1,482	\$22,822	1.0	15.4
COTAL	11.11	47,786.4	(17.58)	145	\$1,136	\$1,141	<b>8</b>	\$2,277	\$30,072		13.2
								100			0.00
400	0.53	1,723	(2.96)	က	\$30	\$54	\$0.00	\$85	\$2,417	6.0	28.5
207	3.17	15,020	(28.50)	23	\$250	\$325	\$0.00	\$575	\$17,634	0.4	30.6
505	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
206	0.32	19,718	(8.14)	29	\$465	\$33	\$0.00	\$498	\$29,154	0.3	9.85
202	0.32	19,718	(8.14)	69	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
208	0.32	19,718	(8.14)	69	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
209	0.32	19,718	(8.14)	29	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
510	0.32	19,718	(8.14)	29	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
511	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
512	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
513	0.32	19,718	(8.14)	69	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
514	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
401	0	951	(1.60)	2	\$17	\$0	\$0.00	\$17	\$2,208	0.1	131.6

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem LOCAT	LABOR Total Unit Hrs Price 0.25 \$21.17	DACA 21 – 91 – C – 0097  X CODE A CODE OTHER  C C C C C C C C C C C C C C C C C C C	CODE B CODE C	)E C	DATE APR 92 DRAWING NO.	<b>8</b> 0	16-Apr-92 SHT OF	
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INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS TASK DESCRIPTION T	LABOR Total Hrs 0.25	]						
INDIVIDUAL OFFICES: SINGLE LEVEL LIGHTING CONTROL FROM OCCUPANCY SENSORS TASK DESCRIPTION TASK DESCRIPTION TASK DESCRIPTION TASK DESCRIPTION TASK DESCRIPTION TO OUT UNITS Meass #W-120A IFRARED SENSOR TEACH TO OUT THE MEAST TO O	LABOR Total Hrs				ESTIMATOR PING	PMG	CHECKED BY CE.	щ
CONTROL FROM OCCUPANCY SENSORS  TASK DESCRIPTION  TASK DESCRIPTION  Units Meass  #W-120A IFRARED SENSOR  1 EA  #W-120A IFRARED SENSOR  1 EA	Hrs Hrs 0.25		EQUIPMENT	MATE	MATERIAL	TOTAL	SHIPPING	(5)
TASK DESCRIPTION  Weas  #W-120A IFRARED SENSOR  1 EA  #WO-120A IFRARED SENSOR  1 EA  1 EA  1 EA  1 EA	Hrs 0.25		Chit	Coit			ŧ	Total
#W-120A IFRARED SENSOR 1 EA	0.25	1	Price	Cost Price	Cost		¥	₹
<b>5</b>	Q	47		\$40.00	64000	\$45.29		
						27.55		
SUBTOTAL		\$5.28			\$40.00	"		
OVERHEAD, BOND		\$0.73			\$6.00	£.03		
PROFIT 10%		\$0.53			\$4.00	<b>3</b>		
COST SUB-TOTAL		\$6.62			\$50.00	\$56.62		
CONTINGENCY 15%		\$0.99			\$7.50	\$8.40		
TOTAL		\$7.61			\$57.50	\$65.11		

PROJECT LOCATION INDIVIDUAL CONTROL F TASK DES FROMER PAC REMOVEW SENSORWI SENSORWI SENSORWI SENSORWI OVERHEAE PROFIT COST SUE	PROJECT F Metherson & P. Gillen ESOS Study	COST FSTIMALE ANALYSIS	<u>လ</u>			Z	VITATION NO.A	INVITATION NO./CONTRACT NO.			<b>EFFECTIVE PRICING</b>	RICING	DATE PREPARED	CE CE
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## 10000-LITTRACING SENSOR    EA	### 1000A-ULTPASONIC SENSOR 1 EM 3.31 \$23.17 \$70.07  POWERPACK WENTCHWIRNO 1 EM 0.56 0.55 \$21.17 \$20.11  FEMOVE WILL SWITCHWIRNO 1 EM 0.56 0.55 \$21.17 \$20.11  FEMOVE WILL SWITCHWIRNO 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR WIRNOJCONNECTIONS 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR WIRNOJCONNECTIONS 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR WIRNOJCONNECTIONS 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR WIRNOJCONNECTIONS 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.16  SENSOR SENSOR 1 EM 0.56 0.55 \$21.17 \$10.17  SENSOR SENSOR 1 EM 0.56 0.55 \$20.17 \$10.17  SENSOR 1 EM 0.56 0.55 0.55 0.55 0.55 0.55 0.55 0.55	Units			E E	Price	Set	Price	Cost	Price	Cost		¥	₹
#W1000A-ULTPAGONIC SENSOR  PEWISPRACK #PACTY  FOUNDERPOCK #PACTY	POWER PACK ##2770  FENNOYE WALL SWITCH-WITNING CONNECTIONS  FENNOYE WALL SWITCH-WITNING TO A 1 EA 0.045 \$21.17 \$50.01  FENNOYE WALL SWITCH-WITNING TO A 1 EA 0.045 \$21.17 \$50.01  FENNOYE WALL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WALL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17 \$50.01  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYE WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOYER WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY WELL SWITCH-WITNING TO A 1 EA 0.046 \$21.17  FENNOY			_										
FOWEREAL SWITCHWIRNG  TEAMOVE WALL SWITCHWIR	POWERPACK ##2770  FEMOVERPACK ##2770  FEMOVERP	-	$\vdash$	3.31		\$21.17	\$70.07			\$82.00	\$85.00			
Second Second	SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.16  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.16  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.16  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.16  SUBTOTAL  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.16  SUBTOTAL  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.10  SUBTOTAL  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$10.10  SUBTOTAL  SENSORWIRING/CONNECTIONS 1 EA 0.49 \$21.17 \$11.17  SUBTOTAL  SUBTOT	-	-	0.95		\$21.17	\$20.11			\$25.00		\$45.11		
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8615							\$23				\$26			
							\$173				\$198			

DA FORM 5418-R, APR 85

COST ESTIMATE ANALYSIS	NALY	SIS				INVITATION NO./CONTRACT NO.	CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	ED
						DACA 21-91-C-0097	-C-0097			DATE APR 92	2	Ā	!
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E ECTRICAL REWIRING FOR MULTIPLE	Quantity	Hit		LABOR	ac.		EQUIPMENT	ENT	MATERIAL	<b>I</b> ≱	TOTAL	SHIPPING	g
LIGHT SWITCHING A INF VOLTAGE	2	Conit	Ì	Total	5		Chit		Tie.			Ç	Total
TASK DESCRIPTION	Onits		C	Hrs	Price	Cost	Price	Cost	Price	Cost		¥	₹
ADD LIGHT SWITCH													
SWITCH AND COVERPLATE	<b>-</b>	ā	0.4	0.4	\$21.17	\$8.47			\$6.45	\$6.45	\$14.92		
OUTLET BOX AND EXT. RING		ā	0.55	0.55		\$11.64			\$4.65	<b>2</b> 2	\$16.29		
MOUNT SWITCHBOX, PATCH AND REPAIR 5.5' DRYWALL, PLASTER, PAINT		2	n	8	\$21.17	\$63.51			\$20.00	\$20.00	\$83.51		
CONDUIT AND WIRE	0.2	Q.F.	6.15	1.23	\$21.17	\$26.04			\$47.00	\$9.40	\$35.44		
CONNECTIONS AT CEILING LIGHT		Æ	0.5	0.5	\$21.17	\$10.59			\$3.00	\$3.00	\$13.59		
WIREMOLD SURFACE METAL PACEWAY	S	<u> </u>	0.8	4	\$21.17	\$84.68			\$0.47	\$2.35	\$87.03		
SWITCHBOX AND SWITCH	-		0.7	0.7					\$10.00	\$10.00	\$24.82		
SUBTOTAL						\$219.74				\$55.85	\$275.59		
OVERHEAD, BOND	15%					\$32.96				\$8.38	<b>\$1.3</b>		
PROFIT	10%					\$21.97				\$5.59	\$27.56		
COST SUB-TOTAL						\$274.68				\$69.81	\$344.49		
CONTINGENCY	15%					\$41.20				\$10.47			
TOTAL						\$315.88				\$80.28	\$396.17		



## **Passive Infrared Wall Switch**

- Simply replaces existing light switches
- Large 1000 sq. ft. of coverage
- Built-in light level sensor
- Adjustable Sensitivity & Time Delay
- Advanced transformer/latching relay design
- Compatible with Electronic Ballasts
- Proven 30% to 70% savings
- Available in 24VDC and 24V Half Wave
- Three-year warranty; UL Listed



**System Information** 

The Watt Stopper WI sensors simply replace

existing wall switches and turn lighting systems on only when offices, conference rooms, copy rooms or utility rooms are actually occupied. Lighting systems are automatically turned off after the controlled area is left unoccupied for a user-specified length of time. When the area is used again, the lights are automatically turned on. Savings of 30% to 70% are common.

**Sensor Operation** 

Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

Advanced Light-Level Sensing

WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

Design

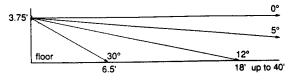
WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

## Applications and Economics

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates. They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585





## WI Sensor Technical Information

#### WI Sensor Specifications

- Part of a completely integrated line of lighting control products
- Coverage: covers a 180° area 40 foot range with adjustment
- Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- Adjustable unit sensitivity
- Integrated light level sensor works from 5 to 400 footcandles
- Red LED display to indicate detection
- Advanced transformer/latching relay design for WI-120A & WI-277A
- Works with solid-state ballasts and PL type lamps
- No leakage current in off mode Patent Pending
- Small size 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- Voltage drop protection Patent Pending
- Integrated four level fresnel lens Patent Pending
- Three-year warranty; UL Listed
- Available in Tamper Proof Model, and in White or Ivory

#### Ordering Information

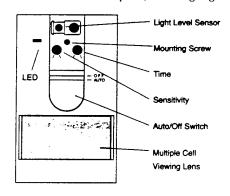
Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for	Two Gang Box		1
ASP-112	Switch Plate C	over-Dual Switch		1

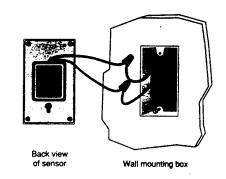
Notes: \*1 - Add a TP to Catalog No. for Tamper Proof, and add a W for White or I for Ivory

\*2 - Used with Watt Stopper Power Packs

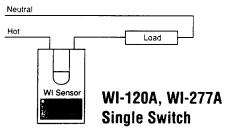
\*3 - For half-wave pulse, low-voltage lighting systems

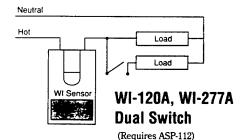
## Product Controls and Installation

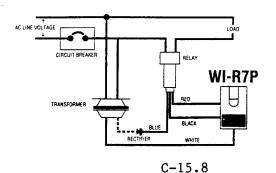


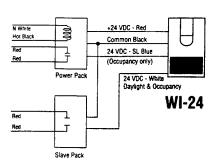


#### **Circuit Schematics**







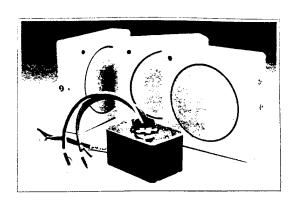


The Watt Stopper, Inc. Santa Clara, CA 95050 Pub. No. 0302



## **Ultrasonic Sensors**

- ◆ Proven 30% to 60% savings; Turn lights on only when needed
- 500, 1000 and 2000 sq. ft. coverages available
- ◆ Adjustable sensitivity & time delay
- ◆ Fully-integrated product line
- ◆ UL Listed; Three-year warranty



#### **Complete Systems** Integration

Operation

**Features** 

**Applications** 

**Economics** 

The Watt Stopper, Inc.

Santa Clara, CA 95050 TEL: (408) 988-5331 FAX: (408) 988-5373 Plano, TX 75023 1-800-879-8585 Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- ◆ Solid State, crystal-controlled (25 KHZ±.005)
- ♦ Omni-directional transmission (360° coverage)
- ◆ Temperature and humidity-resistant 25 KHZ Microphone Receivers
- ♦ Logic Key/ON bypass
- ◆ 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- ◆ Available in White or Ivory

## **Ultrasonic Sensor Technical**

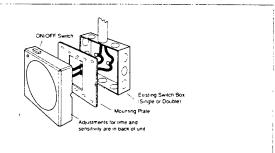
#### **Ordering Information**

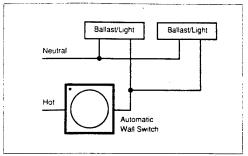
Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft 180°	
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft 180°	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft 360°	1,2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft 360°	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft 360°	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

- \*1 Used with Watt Stopper Power Packs.
- \*2 Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.

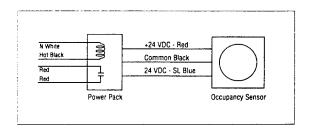
Note: Standard models are White, add an I to Catalog No. for Ivory.

# Wall Switch Placement and Schematic





#### Ceiling Sensor Placement and Schematic



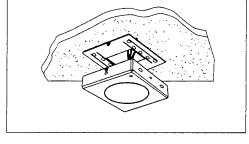


Figure A Figure B

Sensor

Fixtures

Fixtures

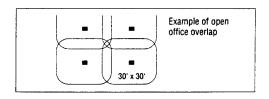
Sensor

Correct

Incorrect

For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.

For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.



For open office space the W-2000A is the

most often used because of its true 360°

coverage and capability to bounce off of

partitions, walls, floors and other reflecting objects to sense motion. A typical

layout for open office space is for the

ultrasonic sensors to control the office

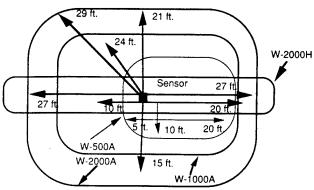
about 25' x 25' for the lighting fixtures

and an overlap on the sensor coverage

that picks up to 30' x 30'.

area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is

#### Ceiling Sensor Coverage



\*\*The W-2000H drawing is not drawn to scale. Coverage is 10' x 100' in a hallway, walls are necessary for this coverage pattern.

The Watt Stopper, Inc. Santa Clara, CA 95050 Pub. No. 0102

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: JW CHECKED BY: CEL

EXIT SIGNS:

70

**BUILDING NUMBER:** 

101

Sheet 1 of 5

Schedule #1	M-F	600 to	2100	s-s	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room	# of	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
No.	Fixtures		on	yes	no	2	по
218	17	4x2-4 lamp fluorescent		yes	no	2	yes
220	12	i	on	yes	no	1	yes
222	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
223	1	4x2-2 lamp fluorescent	on		no	4	no
225	18		off	yes	no	1	no
227	10	Land the second	on	yes	no	3	no
228	16	4x2-4 lamp fluorescent	on	yes	no	1	yes
229	3		on	yes	no	1	no
230	2		off	yes	no	1	по
232	1		off	yes		1	no
236	4		on	yes	no	1	yes
336		4x2-4 lamp fluorescent	on	yes	no	1	no
339	5	<u> </u>	on	yes	no	1	no
341	2		on	yes	no	1	no
343	2		on	yes	no	1	no
342	4		on	yes	уөѕ	0	
345	3		on	no	yes	12	yes no
201	64		on	yes	no	12	
204	3		on	yes	no	1	no
207	3	4x2-4 lamp fluorescent	on	yes	no		no
209	3		on	yes	по	1	no
210	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
211	2		on	yes	no	1	yes
212	1	4x2-4 lamp fluorescent	on	no	no	0	yes
213	11	4x2-4 lamp fluorescent	on	yes	по	3	уөз
214	14	4x2-4 lamp fluorescent	on	yes	no	3	no
215	2	4x2-4 lamp fluorescent	on	no	no	0	yes
216	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
433	2	60 Watt Incandescent	off	yes	no	1	yes
301	1	4x2-4 lamp fluorescent	off	yes	no .	1_	no
303	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
305	2	4x2-4 lamp fluorescent	off	yes	yes	1	по
307	16	4x2-4 lamp fluorescent	on	yes	no	2	no
311	1		on	yes	по	1	yes
312	3	4x2-4 lamp fluorescent	on	yes	no	1	no
316	3		on	yes	уөѕ	1	yes
317	5		OF	yes	no	11_	no
320	1		on	yes	yes	1	yes
322	1	+···	off	yes	no	1	no
324	1		off	no	no	0	no
328	1		off	no	no	0	no
330	68		оп	yes	no	17	по
332	2		on	yes	yes	1	yes
334	1	<del></del>	on	yes	no	1	по
401	25		on	yes	no	6	no
403	2		оп	yes	no	1	yes
405		4x2-4 lamp fluorescent	off	yes	yes	1	no

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JA

PREPARED BY: JW CHECKED BY: CEL

**BUILDING NUMBER:** 

101

Sheet 2 of 5

Schedule #1	M-F	600 to	2100	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of	Unocc. Lights
No.	Lights	75.14	Survey	Yes/No	Sensor	Switches	On
407		75 Watt Incandescent	off	yes	no	1	no
409	7	The state of the s	on	yes	по	1	по
411		2x2-2 U-Bulb fluorescent	on	yes	no	2	no
413	2		on	yes	по	1	yes
414		4x2-4 lamp fluorescent	off	yes	yes	1	no
416	3		off	yes	yes	1	no
419	2		off	yes	по	1	no
422	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
423	2	8'-2 lamp fluorescent	off	no	yes	0	no
425	1	8'-2 lamp fluorescent	off	yes	по	1	по
427	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
429	47		on	yes	no	12	no
252	6		on	yes	no	3	yes
253		2x2-2 U-Bulb fluorescent	off	yes	no	1	по
254		60 Watt Incandescent	off	yes	no	1	no
233		4x2-4 lamp fluorescent	off	yes	yes	1	по
234	9	4x2-4 lamp fluorescent	on	yes	no	2	по
235	3	4x2-4 lamp fluorescent	on	yes	no	1	по
237	16	4x2-4 lamp fluorescent	on	yes	no	2	no
238	4		on	yes	no	1	yes
239	5		on	yes	по	2	yes
240	1		on	yes	no	1	yes
241		2x2-2 U-Bulb fluorescent	off	yes	no	1	no
242		4x2-4 lamp fluorescent	on	yes	no	1	yes
243		4x2-4 lamp fluorescent	on	yes	no	1	yes
244	1	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
245	1	60 Watt Incandescent	off	yes	no	1	no
246		4x2-4 lamp fluorescent	on	yes	no	1	no
247	3	4x2-4 lamp fluorescent	on	yes	no	1	no
248	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
249	3	4x2-4 lamp fluorescent	on	yes	no	1	по
250	8	4x2-4 lamp fluorescent	on	yes	no	2	по
251	5	4x2-4 lamp fluorescent	on	yes	no	1	no
333	9	4x2-4 lamp fluorescent	on	yes	no	3	no
335	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
337	5	4x2-4 lamp fluorescent	on	yes	no	1	по
338	2	4x2-4 lamp fluorescent	on	yes	yes	1	по
340	3	4x2-4 lamp fluorescent	on	yes	по	1	yes
344	2	4x2-4 lamp fluorescent	on	no	no	0	yes
200	5	4x2-4 lamp fluorescent	on	yes	по	1	no
202	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
203	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
205	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
206	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
217	2	4x2-4 lamp fluorescent	off	yes	yes	1	по
219	63	4x2-4 lamp fluorescent	on	yes	no	8	no
221	1	60 Watt Incandescent	off	ves	по	1	по

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: CHECKED BY:

CEL

#### **BUILDING NUMBER:**

101

Sheet 3 of 5

Schedule #1	M-F	600 to	2100	s-s	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	Na. of	Unoce. Lights
No.	Fixtures	•	Survey	Yes/No	Sensor	Switches	On
224	4	4x2-4 lamp fluorescent	on	yes	no	1	no
226	8	4x2-4 lamp fluorescent	on	yes	no	2	no
231	7	4x2-4 lamp fluorescent	on	yes	no	2	ПО
300	5	4x2-4 lamp fluorescent	on	yes	по	2	no
302	6	4x2-4 lamp fluorescent	on	yes	no	1	по
304	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
306	9	4x2-4 lamp fluorescent	on	yes	no	2	по
307	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
308	98	4x2-4 lamp fluorescent	on	yes	no	8	по
310	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
314	10	4x2-4 lamp fluorescent	on	yes	no	2	no
313	6		on	yes	yes	1	yes
318	2		on	yes	yes	1	yes
321	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
323	85		on	yes	no	10	no
325	3	4x2-4 lamp fluorescent	off	yes	yes	1	по
326	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
327	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
329	2	·	on	yes	yes	1	no
331	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
400	6		on	yes	no	2	no
402	10	+ · · · · · · · · · · · · · · · · · · ·	on	yes	no	2	по
406	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
404		4x2-4 lamp fluorescent	on	yes	yes	1	no
408	2	8'-2 lamp fluorescent	off	yes	no	1	no
408	1	4x2-2 lamp fluorescent	off	yes	по	1	no
410	8	4x2-4 lamp fluorescent	on	yes	no	1	no
412	48	4x2-4 lamp fluorescent	on	yes	по	5	no
420	4		on	yes	yes	1	yes
421	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
424	1	200 Watt Incandescent	off	no	yes	0	no
426	5	4x2-4 lamp fluorescent	on	yes	no	1	no
428	8	4x2-4 lamp fluorescent	off	yes	yes	1	no
428	3	2x2-2 U-Bulb fluorescent	off	yes	yes	11_	no
430	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
431	3	4x2-2 lamp fluorescent	on	yes	no	1	no
432	3	4x2-2 lamp fluorescent	on	yes	по	1	no
39	1	150 Watt Incandescent	on	yes	yes	1	yes
25	1	4x2-4 lamp fluorescent	on	yes	уөз	1	yes
24	18	4x2-4 lamp fluorescent	on	yes	по	7	no
26	6		on	yes	yes	1	по
23	8	4x2-4 lamp fluorescent	on	yes	yes	1	no
22	9		on	yes	no	1	no
46		4x2-4 lamp fluorescent	on	yes	yes	1	no
46A	1	150 Watt Incandescent	on	yes	yes	1	yes
75	8	4x2-4 jamp fluorescent	оп	yes	no	1	по
74	8	4x2-4 lamp fluorescent	on	yes	по	1	no

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY LOCATION: FORT GILLEM

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

22-Apr-92 DATE:

FILE: PREPARED BY:

G101LITE.WK3 JW

CHECKED BY:

CEL

#### **BUILDING NUMBER:**

101

Sheet 4 of 5

Schedule #1	M-F	600 to	2100	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

			On/Off		Good For		Unocc.
Room	# of	Fixture Description	During	Switch	Occup.	No. of	Lights
No.	Lights		Survey	Yes/No	Sensor	Switches	On
'4A	1	4x2-4 lamp fluorescent	off	yes	yes	1.	по
'3A	1	4x2-4 lamp fluorescent	off	yes	yes	1	по
73	10		on	yes	no	1	no
72	4	4x2-4 lamp fluorescent	off	yes	no	1	no
71	. 12	4x2-4 lamp fluorescent	on	yes_	по	1	no
HALL-1	8	4x2-4 lamp fluorescent	on	yes	no	2	no
67	2	8'-2 lamp fluorescent	off	yes	no	1	по
70	2	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
61	6	4x2-4 lamp fluorescent	on	yes	no	2	no
68	1	8'-2 lamp fluorescent	on	yes	no	1	no
59	1	150 Watt Incandescent	off	yes	no	1	no
59	2	4x2-2 lamp fluorescent	off	yes	no	1	no
60	2	4x2-4 lamp fluorescent	off	yes	no	1	по
21	20	4x2-4 lamp fluorescent	оп	yes	no	2	no
58	6	4x2-4 lamp fluorescent	оп	yes	по	1	no
57A	1	4x2-4 lamp fluorescent	off	yes	по	1	по
57	1	4x2-2 lamp fluorescent	off	yes	по	1	no
56	2	4x2-4 lamp fluorescent	off	yes	по	1	no
54	3	4x2-4 lamp fluorescent	on	yes	no	1	no
55	3	1	off	yes	yes	1	no
53	4	4x2-4 lamp fluorescent	on	yes	yes	1	по
53A	<del></del>	4x2-4 lamp fluorescent	on	yes	yes	1	no
3B	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
51	2	4x2-4 lamp fluorescent	on	yes	по	1	yes
52	1	4x2-4 lamp fluorescent	on	no	yes	0	no
50	+	4x2-4 lamp fluorescent	оп	no	yes	0	yes
49	3		on	yes	по	1	yes
48	12		on	yes	по	2	yes
47	6		off	yes	yes	1	по
45	2		off	yes	yes	1	по
45	2		off	yes	yes	1	no
44	1	150 Watt incandescent	on	yes	no	1	yes
43	1	150 Watt Incandescent	on	yes	no	1	yes
34	4	4x2-4 lamp fluorescent	on	yes	yes	1	ПО
71	12		on	yes	no	1	no
68	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
61	8	4x2-2 lamp fluorescent	on	yes	no	2	по
60	2	4x2-4 lamp fluorescent	off	yes	yes	1	по
59	1	150 Watt Incandescent	on	yes	yes	1	по
59	2		on	yes	yes	1	no
21	20		on	yes	no	1	no
21	10	<u> </u>	off	yes	no	1	по
40	2		on	yes	yes	1	yes
41	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
27	12	l	on	yes	no	1	yes
7A	2	4x2-2 lamp fluorescent	on	yes	no	1	no

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION: FORT GILLEM

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92 DATE:

G101LITE.WK3 FILE:

PREPARED BY: CHECKED BY:

CEL

**BUILDING NUMBER:** 101

Sheet 5 of 5

 
 Schedule #1
 M-F
 600 to
 2100
 S-S

 Schedule #2
 M-F
 0 to
 0
 S-S
 0 to 0 to

				On/Off		Good For		Unocc.
Roc	om	# of	Fixture Description	During	Switch	Оссир.	No. of	Lights
No	,	Lights		Survey	Yes/No	Sensor	Switchee	On
	28	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
	8	8	2x2-2 U-Bulb fluorescent	off	yes	no	1	по
2A		4	4x2-4 lamp fluorescent	on	no	yes	0	yes
2C		4	4x2-4 lamp fluorescent	on	по	yes	0	yes
2B	-	8	4x2-4 lamp fluorescent	on	no	yes	0	yes
5A		2	4x2-4 lamp fluorescent	on	yes	yes	1	no
5B		2	4x2-4 lamp fluorescent	on	yes	yes	1	no
	6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
зА		5	4x2-4 lamp fluorescent	on	yes	yes	1	по
3B		1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
	19	3	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
	13	52	12V-75W HALOGEN	off	yes	по	1	no
<del></del>	14	3	8'-2 lamp fluorescent	off	yes	по	1	no
14A	<u> </u>	1	4x2-4 lamp fluorescent	off	yes	no	1	no
<del>- • • • • • • • • • • • • • • • • • • •</del>	20	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
	16	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
	15	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
14B		2	4x2-4 lamp fluorescent	off	yes	по	1	по
65A		8	4x2-4 lamp fluorescent	off	no	yes	0	yes
65B		6	4x2-4 lamp fluorescent	on	по	по	0	yes
65C		8	4x2-4 lamp fluorescent	off	no	no	1	no
65D		12	4x2-4 lamp fluorescent	on	yes	no	1	по
	76	1	4x2-4 lamp fluorescent	off	yes	no	1	no
	86	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
88A		1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
-	88	2	4x2-2 lamp fluorescent	оп	yes	no	1	yes
	77	8		on	yes	yes	1	yes
	85	1		off	yes	yes	1	no
	88	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
	87	1	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
	87	2		on	yes	yes	1	уев
	78	4	<u> </u>	off	yes	yes	2	по
	79	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
-	80	5		on	yes	yes	1	по
	81	1		off	yes	yes	1	по
	82	1	<del></del>	off	yes	yes	1	no
-	84	1		off	yes	уөз	1	no
	83	8		off	yes	yes	1	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: CHECKED BY:

JW CEL

#### **BUILDING NUMBER:**

101

Sheet 1 of 5

% Unnoc. lights: Gas Increase Factor 19%

3.60E-04 MBtu/kWh

Cooling Factor (Energy)

1.16

							Cost of Switches					
1	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Houre 'On'	kW/Month	k₩h	Increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
218	2.64	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
220	2.52	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
222	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
223	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
225	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
227	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
228	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
229	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
230	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
232	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
236	0.62	3915	0.00	Ō	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
336	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
339	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
341	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
343	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
342	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
345	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.00
201	9.92	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
204	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
207	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
209	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
210	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
211	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
212	0.16	3915	0.00	40	0.015	47	1	\$396.17	NO	\$0.00	NO	\$0.00
213	1.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
214	2.17	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
215	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00	NO	\$0.00
216	0.62	3915	0.12	461	0.166	535	Ö	\$0.00	NO	\$0.00	YES	\$372.00
433	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
301	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
303	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
305	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
307	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
311	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
312	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
316	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65,11	NO	\$0.00
317	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
320	0.78	3915	0.00	66	0.024	77	0	\$0.00	YES	A CONTRACTOR OF THE PARTY OF TH		
322										\$65.11	NO	\$0.00
	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
324	. 0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
328	0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
330	10.54	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
332	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
334	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
401	3.88	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
403	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
405	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
1			T	2607.841						\$455.77		

PROJECT: FORT MoPHERSON & FORT GILLEM EEAP STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92 DATE:

G101LITE.WK3 FILE:

PREPARED BY: JW CEL

CHECKED BY:

Sheet 2 of 5

#### **BUILDING NUMBER:**

101

% Unnoc. lights:

19%

3.60E-04 MBtu/kWh Gas Increase Factor

Cooling Factor (Energy) 1.16

								41 28.		Switchee		
Room	Total kW/Month	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/vi	Total kWh	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
No.	Lighting 0.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
407	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
409	0.46	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
411	0.46	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
413	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
414		3915	0.12	346	0.125	401	o	\$0.00	YES	\$65.11	NO	\$0.00
416	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
419	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
422	0.47	3915	0.08	109	0.039	127	1	\$396.17	YES	\$65.11	NO	\$0.00
423	0.42		0.00	0	0.000	- ,_,	Ö	\$0.00	NO	\$0.00	NO	\$0.00
425	0.21	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
427	0.31	3915		0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
429	7.29	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
252	0.93	3915 3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
253	0.09			0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
254	0.06	3915	0.00	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
233	0.31	3915	0.06	231	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
234	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
235	0.47	3915	0.00			- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
237	2.48	3915	0.00	0	0.000	- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
238	0.62	3915	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.00
239	0.78	3915	0.00	0	0.000	- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
240	0.16	3915	0.00	0	0.000		0	\$0.00	NO	\$0.00	NO	\$0.00
241	0.09	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.00
242	0.16	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.00
243	0.31	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.00
244	0.09	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.00
245	0.06	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.00
246	0.47	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00		\$0.00
247	0.47	3915		0		0		\$0.00	NO	\$0.00		\$0.0
248	0.62	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
249	0.47	3915	0.00	0		0			NO	\$0.00		\$0.0
250	1.24	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
251	0.78	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
333	1.40	3915		0		0		\$0.00		\$0.00		\$0.0
335	0.18	3915		0		0		\$0.00				\$0.0
337	0.78	3915		0		0		\$0.00		\$0.00		\$0.0
338	0.31	3915		231	0.083	267		\$0.00		\$65.11 \$0.00		\$0.0
340	0.47	3915	0.00	0		0		\$0.00				\$0.0
344	0.31	3915	0.00	81		93		\$396.17		\$0.00		\$0.00
200	0.78	3915		0		0		\$0.00		\$0.00		
202	0.47	3915	0.09	346		401	0	\$0.00		\$65.11		\$0.0
203	0.47	3915		346		401	0	\$0.00		\$65.11		\$0.0
205	0.47	3915		346		401	0	\$0.00		\$65.11		\$0.0
206	0.78	3915		576	0.208	669	0			\$0.00		\$372.0
217	0.31	3915		231	0.083	267		\$0.00		\$65.11		\$0.0
219	9.77	3915				C		\$0.00	NO	\$0.00		\$0.0
221	0.06	3915				C	0	\$0.00	NO	\$0.00		\$0.0
1 41	0.00	3913	3.50	3533.406			1			\$585.99	)	<u> </u>

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

DATE: 22-Apr-92 FILE:

G101LITE.WK3

PREPARED BY:

EMC PROJECT: #3105.000

CHECKED BY:

CEL

**BUILDING NUMBER:** 

101

Sheet 3 of 5

% Unnoc. lights:

19%

Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

							:	455.47	Cost	of Switches	7.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1	
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours 'On'	kW/Month	kWh.	Increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	PerYear	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
224	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
226	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
231	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
300	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
302	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
304	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	<b></b>	
306	1.40	3915	0.00	0	0.000	134	0	\$0.00	NO	\$0.00	NO NO	\$0.00
307	0.31	3915	0.06	231	0.083			\$0.00	YES		NO	\$0.00
308	15.19		0.00		0.000	267	0		NO NO	\$65.11		\$0.00
310	0.31	3915 3915	0.06	0		0	0	\$0.00		\$0.00	NO	\$0.00
				231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
314	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
313	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
318	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	<b>\$65.11</b>	NO	\$0.00
321	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
323	13.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
325	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
326	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
327	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
329	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
331	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
400	1.26	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
402	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
406	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
404	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
408	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
408	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
410	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
412	7.44	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
420	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
421	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
424	0.20	3915	0.04	52	0.019	60	1	\$0.00	YES	\$65.11	NO	\$0.00
426	0.78	3915	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00	NO	\$0.00
428	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
428	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
430	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
431	0.02	3915	0.00	0	0.000	0	0	\$0.00	NO			
432	0.27	3915	0.00	0	0.000	0	0	\$0.00		\$0.00	NO	\$0.00
39									NO	\$0.00	NO	\$0.00
	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
25	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
24	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
23	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
22	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
6A	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	<b>\$6</b> 5.11	NO	\$0.00
75	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				7991.855						\$976.65		

PROJECT: FORT MCPHERSON & FORT GILLEM EEAP STUDY

**ÉCO:15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

22-Apr-92 DATE:

FILE: G101LITE.WK3

PREPARED BY:

CHECKED BY: CEL

#### **BUILDING NUMBER:**

101

% Unnoc. lights: Gas Increase Factor 19%

3.60E-04 MBtu/kWh

Cooling Factor (Energy) 1.16

Sheet 4 of 5

							1			f Switches		
Room	Total kW/Month	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas increase (MBtu)/ys	Total kWh	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
No.	Lighting	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
74A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
73A	0.16		0.00	113	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
73	1.55	3915 3915	0.00	0	0.000	- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
72	0.62	3915	0.00	- 0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	1.86		0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-1	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.31	3915 3915	0.00	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
69	0.47		0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
61	0.93	3915 3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.21		0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.15	3915 3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.18		0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	3.10	3915 3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.93		0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
57A	0.16	3915	0.00	0	0.000	- 0		\$0.00	NO	\$0.00	NO	\$0.0
57	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
56	0.31	3915 3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
54	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
55	0.47		0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
53	0.62	3915 3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
53A	0.62		0.12	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
53B	0.47	3915	0.00	340	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
51	0.31	3915	0.03	40	0.005	47	1	\$396.17	YES	\$65.11	NO	\$0.0
52	0.16	3915	0.09	121	0.013	140		\$396.17	YES	\$65.11	NO	\$0.0
50	0.47	3915 3915	0.00	0	0.000	0	<del> </del>	\$0.00	NO	\$0.00	NO	\$0.0
49	0.47		0.00	0	0.000	0	<del></del>	\$0.00	NO	\$0.00	NO	\$0.0
48	1.86	3915	0.00	692	0.249	802		\$0.00	NO	\$0.00		\$372.0
47	0.93	3915 3915	0.18	312	0.112	362	0	\$0.00	YES	\$65.11	NO	\$0.0
45	0.42		0.03	132	0.048	154		\$0.00	YES	\$65.11	NO	\$0.0
45	0.18	3915	0.00	0	0.000	0		\$0.00		\$0.00	NO	\$0.0
44	0.15	3915	0.00	0	0.000	0		\$0.00		\$0.00		\$0.0
43	0.15	3915	0.00	461	0.166	535		\$0.00		\$0.00		\$372.0
34	0.62	3915	0.12	0	0.000	0	+	\$0.00		\$0.00		\$0.0
71	1.86	3915		156	0.056	181	0	\$0.00		\$65.11		\$0.0
68	0.21	3915	0.04	136	<del></del>	0		\$0.00		\$0.00		\$0.0
61	0.71	3915	0.00		0.083	267		\$0.00		\$65.11		\$0.0
60	0.31	3915	0.06	231		129		\$0.00		\$65.11		\$0.0
59	0.15	3915	0.03	112		154		\$0.00		\$65.11		\$0.0
_ 59	0.18	3915	0.03	132					<del></del>	\$0.00		\$0.0
21	0.80	3915	0.00	0		0		\$0.00		\$0.00		\$0.0
21	0.40	3915	0.00	0			<del></del>	<del></del>		\$65.11	<del></del>	\$0.0
40	0.08		0.02	60		69		<del></del>		\$65.11		\$0.0
41	0.16	3915	0.03	115		134				\$0.00		\$0.0
27	0.48	3915	0.00	0		0		\$0.00		\$0.00		\$0.0
7A	0.18	3915	0.00	0		0	0	\$0.00	NO	\$0.00 \$976.65		Ψ0.0
,				4755.218			1	l	L	39/0.00	_L	

19%

3.60E-04 MBtu/kWh

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**BUILDING NUMBER:** 

% Unnoc. lights:

Gas Increase Factor

101

EMC PROJECT: #3105.000

DATE: 22-Apr-92

G101LITE.WK3 FILE: PREPARED BY:

JW CEL

CHECKED BY:

Sheet 5 of 5

							ī		Cost of	Switches	appen e ma	
Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Calling Sensor	Ceifing Sensor Cost
28	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
8	0.74	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
2A	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.0
2C	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.0
2B	1.24	3915	0.24	322	0.116	374	2	\$792.34	NO	\$0.00	YES	\$372.0
		3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.0
5A	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.0
5B	0.31		0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
6	0.62	3915 3915	0.12	576	0.100	669	0	\$0.00	NO	\$0.00	YES	\$372.0
3A	0.78		0.13	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.0
3B	0.16	3915		205	0.042	238	0	\$0.00	YES	\$65.11	NO	\$0.0
19	0.28	3915	0.05	205	0.000	230	0	\$0.00	NO	\$0.00	NO	\$0.0
13	3.90	3915	0.00		<del></del>	0	0	\$0.00	NO	\$0.00	NO -	\$0.0
14	0.63	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
14A	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
20	0.09	3915	0.00				0	\$0.00	YES	\$65.11	NO	\$0.0
16	0.09	3915	0.02	66	0.024	77 267	0	\$0.00	YES	\$65.11	NO	\$0.0
15	0.31	3915	0.06	231	0.083		ļ	\$0.00	NO	\$0.00	NO	\$0.0
14B	0.31	3915	0.00	0		0 074	0 2	\$792.34	NO	\$0.00	YES	\$372.0
65A	1.24	3915	0.24	322	0.116	374	0	\$0.00	NO	\$0.00		\$0.0
65B	0.93	3915	0.00	0		074	2	\$792.34	NO	\$0.00		\$0.0
65C	1.24	3915	0.00	322		374		\$0.00	NO	\$0.00	NO	\$0.0
65D	1.86	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$0.0
76	0.16	3915	0.00	0				\$0.00	YES	\$65.11	NO	\$0.0
86	0.27	3915	0.05	199		230	+	\$0.00	YES	\$65.11	NO	\$0.0
88A	0.16	3915	0.03	115	0.042	134 0	0	\$0.00	NO	\$0.00		\$0.0
88	0.18	3915	0.00	0		1070	0	\$0.00	NO	\$0.00		\$372.0
77	1.24	3915	0.24	922		77	0	\$0.00	YES	\$65.11	NO	\$0.6
85	0.09	3915	0.02	66			0	\$0.00	YES	\$65.11	NO	\$0.
88	0.21	3915	0.04	156		181		\$0.00	YES	\$65.11	NO	\$0.
87	0.09	3915	0.02	68		79			YES	\$65.11	NO	\$0.
87	0.18	3915	0.03	132		154		\$0.00		\$0.00		\$372.
78	0.62	3915	0.12	461	0.166	535		\$0.00	NO YES	\$65.11	NO	\$0.
79	0.31	3915	0.06	81		93		\$396.17				\$372.
80	0.78	3915	0.15	576		669		\$0.00	NO	\$0.00		\$0.
81	0.16	3915	0.03	115		134		\$0.00	YES	\$65.11		
82	0.16	3915	0.03	115		134		\$0.00	YES	\$65.11		\$0.
84	0.16	3915	0.03	115		134		\$0.00	YES	\$65.11		\$0.
83	1.24	3915	0.24	922		1070		\$0.00		\$0.00		\$372.
Total	211.910		7.2751	26340.24	9.48	30555	19	\$7,131.06		\$4,036.82		\$9,300.0

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE:

21-Apr-92

103LITE.WK3 FILE: PREPARED BY:

JW CHECKED BY: CEL

EXIT SIGNS:

Sheet 1 of 1

**BUILDING NUMBER:** 

103

Schedule #1	M-F	600 to	1900_ S-	-S <u>600</u> to	1900
Schedule #2	M-F	0 to	2400 S-	-S <u>0 to</u>	2400

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
2	4	4x2-2 lamp fluorescent	off	yes	по	2	no
3	2	4x2-2 lamp fluorescent	on	yes	no	1	уев
4	1	4x2-2 lamp fluorescent	off	yes	no	1	ПО
5A	1	150 Watt Incandescent	off	yes	yes	1	по
SB	1	150 Watt Incandescent	off	yes	no	1	по
6	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
7	1	150 Watt Incandescent	on	yes	по	1	yes
8	5	8'-2 lamp fluorescent	on	yes	no	4	yes
9	5	4x2-2 lamp fluorescent	off	yes	no	2	no
10	1	120 Watt Incandescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	по	1	no
12	2		off	yes	по	1	по
13	1	4x2-2 lamp fluorescent	off	yes	по	1	уее
14	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
15	20	4x2-2 lamp fluorescent	on	yes	no	3	no
15	4	8'-2 lamp fluorescent	on	yes	no	2	yes
16	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
17	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
18	1	75 Watt Incandescent	on	yes	no	1	yes
19	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
20	4	4x2-2 lamp fluorescent	on	yes	no	1	no
21	1	75 Watt Incandescent	off	yes	no	1	yes

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 21-Apr-92

FILE: 103LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

**BUILDING NUMBER:** 

103

Sheet 1 of 1

% Unnoc. lights:

19%

Gas increase Factor 4.00E-04 MBtu/kWh
Cooling Factor (Energy) 1.18

						{			Cost of 6	Switches		
Acom Na.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gau Increase (MBtu)/y		No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Celling Sensor	Ceiling Sensor Cost
1	0.16	4745	0.03	140	0.056	165	0	\$0.00	YES	<b>\$6</b> 5.11	NO	\$0.00
2	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	0.18	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5A	0.15	4745	0.03	135	0.054	160	0	\$0.00	YES	\$65.11	NO	\$0.00
58	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	<b>\$</b> 65.11	NO	\$0.00
7	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	1.05	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.45	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.12	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.18	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.21	4745	0.04	189	0.076	223	0	\$0.00	YES	\$65.11	NO	\$0.00
15	1.78	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.84	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.47	4745	0.09	419	0.168	495	0	\$0.00	YES	\$65.11	NO	\$0.00
18	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	7.709		0.304	1442.48		1702.126	0	\$0.00		\$390.66		\$0.00
			•	Total \$ Exp	ense =	\$390.66						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92

DATE:

FILE: 207LITE.WK3 PREPARED BY:

W

CHECKED BY:

CEL

EXIT SIGNS:

**BUILDING NUMBER:** 

207

Sheet 1 of 2

600 to 1800 S-S 0 to 0 Schedule #2 M-F 0 to 0 0 to 

			On/Off		Good For		Unoca.
Room	# of	Fixture Description	During	Switch	Occup.	No. of Switches	Lights
No.	Fixtures		Survey	Yes/No	Sensor	ACCURATION OF THE PARTY OF THE	On
BAY-4		8'-2 lamp fluorescent	on	yes	no		yes
3AY-5		8'-2 lamp fluorescent	on	yes	no	1	yes
130		75 Watt Incandescent	off	yes	по	1	ПО
131	15		off	yes	no	1	no
54	6		on	yes	no	1	yes
55	2		off	yes	yes	1	no
56	88		on	yes	no	8	no
57	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
58	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
59	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
60	90		оп	yes	no	8	no
61	3		off	yes	yes	1	no
62	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
63	3		on	yes	no	1	no
64	1	75 Watt Incandescent	on	yes	no	1	no
64	2	4x2-2 lamp fluorescent	on	yes	no	1	no
65		8'-2 lamp fluorescent	off	yes	no	1	по
66	1	† · · · · · · · · · · · · · · · · · ·	on	yes	no	1	yes
67	1	· · · · · · · · · · · · · · · · · · ·	on	yes	yes	1	yes
36	4		on	yes	yes	1	yes
37	1	<del></del>	off	yes	no	1	no
38	35		оп	no	по	0	yes
39	6	4x2-4 lamp fluorescent	on	yes	no	1	по
40	6	4x2-4 lamp fluorescent	on	yes	no	1	по
41	66		on	yes	по	8	yes
42		8'-2 lamp fluorescent	on	yes	no	6	yes
43	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
44	6	4x2-4 lamp fluorescent	off	yes	yes	1	no
45	21		on	yes	no	1	no
45	4	+ · ·	off	yes	yes	1	по
47	3	4x2-4 lamp fluorescent	off	yes	yes	1	по
	+		off	yes	yes	1	no
.48 49	2	4x2-4 lamp fluorescent 4x2-4 lamp fluorescent	on	yes	yes	1	yes
	+	4x2-4 lamp fluorescent	on	yes	yes yes	1	yes
50	4		on		yes	1	no
51	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
52	2	4x2-4 lamp fluorescent		yes		1	yes
53	6	4x2-4 lamp fluorescent	on of	yes	no	1	no
18	1	4x2-4 lamp fluorescent	off	yes	no	1	no
19	2	4x2-4 lamp fluorescent	on	yes	no	1	
20	2	4x2-4 lamp fluorescent	on	yes	yes		yes
21	6	2x2-2U-Bulb fluorescent	on	yes	yes	1	no
22	6	2x2-2 U-Bulb fluorescent	on	yes	уев	1	yes
23	.6		on	yes	yes	1	yes
24	6	4x2-4 lamp fluorescent	on	yes	no	1	no
25	8		on	yes	yes	2	yes
26	3		on	yes	no	1	no
27	6		on	yes	по	2	по

PROJECT: FORT MoPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

207LITE.WK3

PREPARED BY:

JW

CHECKED BY:

CEL

**BUILDING NUMBER:** 

207

Sheet 2 of 2

 Schedule #1
 M-F
 600 to
 1800
 S-S

 Schedule #2
 M-F
 0 to
 0 S-S

0\_to \_\_

Floorn No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unoca. Ughta On
27	2	2x2-2U-Bulb fluorescent	on	no	no	0	ПО
28	6	2x2-2U-Bulb fluorescent	on	yes	yes	1	no
29	14	4x2-4 lamp fluorescent	on	yes	по	3	ПО
30	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
30	1	2x2-2U-Bulb fluorescent	on	no	yes	0	no
31	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
31	2	2x2-2U-Bulb fluorescent	off	no	yes	0	по
32	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
32	2	2x2-2U-Bulb fluorescent	on	no	no	0	Ves
33	6	4x2-4 lamp fluorescent	on	yes	по	1	по
34	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
35	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
1	10	4x2-4 lamp fluorescent	on	ves	no	2	по
2	2		on	yes	ves	1	yes
3	1	8'-2 lamp fluorescent	off	yes	ves	1	по
4	1	8'-2 lamp fluorescent	off	ves	ves	1	по
5	15	8'-2 lamp fluorescent	оп	ves	no	1	no
6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
7	43	8'-2 lamp fluorescent	on	yes	no	1	yes
8	2	8'-2 lamp fluorescent	on	yes	no	1	no
9	3	4x2-4 lamp fluorescent	on	yes	no	1	по
10	1	4x2-2 lamp fluorescent	оп	yes	no	1	Ves
11	4	4x2-2 lamp fluorescent	off	yes	yes	1	no
12	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
13	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
4a	2	4x2-4 lamp fluorescent	on	yes	no	1	no
4b	4	4x2-4 lamp fluorescent	on	yes	no	1	no
15	6	4x2-4 lamp fluorescent	on	yes	no	1	no
16	7	4x2-4 lamp fluorescent	on	yes	по	1	no
17	4		off	ves	yes	1	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 207LITE.WK3
PREPARED BY:

PREPARED BY: JW CHECKED BY: CEL

**BUILDING NUMBER:** 

207

Sheet 1 of 2

 % Unnoc. lights:
 19%

 Gas Increase Factor
 1.90E-03 MBtu/kWh

 Cooling Factor (Energy)
 0

									Cost of	Switches		
Floorn No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
BAY-4	9.45	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
BAY-5	9.45	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
130	1.13	3132	0.00	0	0.000	ō	0	\$0.00	NO	\$0.00	NO	\$0.00
131	1.13	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
56	7.83	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
57	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
58	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
59	0.47	3132	0.09	277	0.526	0	0	\$0.00	YES	\$65.11	NO	\$0.00
60	8.01	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
61	0.27	3132	0.05	159	0.302	0	0	\$0.00	YES	\$65.11	NO	\$0.00
	0.27	3132	0.00	139	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
62		3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
63	0.27		0.00	0	0.000	- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.08	3132			0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.18	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	0.42	3132	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.21	3132	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
67	0.08	3132	0.01	45	0.085	0	0	\$0.00	NO NO	\$0.00	YES	\$372.00
36	0.62	3132	0.12	369	0.701		0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.16	3132	0.00	0	0.000	0	6	\$2,377.02	NO	\$0.00	NO	\$0.00
38	7.35	3132	0.00	1911	3.631	0		\$0.00	NO	\$0.00	NO	\$0.00
39	0.93	3132	0.00	0	0.000	0	0		NO	\$0.00	NO	\$0.00
40	0.93	3132	0.00	0	0.000	0	0	\$0.00		\$0.00	NO	\$0.00
41	13.86	3132	0.00	0	0.000	0	0	\$0.00	NO NO		NO	\$0.00
42	8.40	3132	0.00	0	0.000	0	0	\$0.00		\$0.00		
43	0.09	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO YES	\$0.00 \$372.00
44	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00		
45	1.87	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
47	0.47	3132	0.09	277	0.526	0	0	\$0.00	YES	\$65.11	NO	\$0.00
48	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
49	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
50	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
51	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
52	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	<b>\$65.11</b>	NO	\$0.00
53	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	0.16	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
20	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
22	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
23	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
24	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
25	1.24	3132	0.24	738	1.402	0	0	\$0.00	NO	\$0.00	YES	\$372.00
26	0.47	3132	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00	NO	\$0.00
27	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
	0.50	0102	5.50	8449.739	0.030		† <u>-</u>			\$585.99		

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

#### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 207LITE.WK3 PREPARED BY: W

CHECKED BY:

CEL

**BUILDING NUMBER:** 

207

Sheet 2 of 2

Gas Increase Factor 0 0010

0.0019 MBtu/kWh Cooling Factor (Energy)

	·			····					Cost of	Switches		
Room	Total kW/Month	Hours *On*	Lighting kW/Month	Lighting kWh	Total Gas increase	Total kWh	No. at New	New Switches	Suitable for Wall	Wall Sensor	Suitable for Ceiling	Ceiling Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
27	0.18	3132	0.00	48	0.091	0	1	\$396.17	NO	\$0.00	NO	\$0.00
28	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
29	2.17	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
30	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
30	0.09	3132	0.02	24	0.045	0	1	\$396.17	YES	\$65.11	NO	\$0.00
31	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
31	0.18	3132	0.03	48	0.091	0	1	\$396.17	YES	\$65.11	NO	\$0.00
32	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
32	0.18	3132	0.00	48	0.091	0	1	\$396.17	NO	\$0.00	NO	\$0.00
33	0.93	3132	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00	NO	\$0.00
34	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
35	0.18	3132	0.03	106	0.201	0	0	\$0.00	YES	\$65.11	NO	\$0.00
1	1.55	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
3	0.21	3132	0.04	125	0.237	0	0	\$0.00	YES	\$65.11	NO	\$0.00
4	0.21	3132	0.04	125	0.237	0	0	\$0.00	YES	\$65.11	NO	\$0.00
5	3.15	3132	0.00	819	1.556	0	3	\$1,188.51	NO	\$0.00	NO	\$0.
6	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
7	9.03	3132	0.00	2348	4.461	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
8	0.42	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.09	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.36	3132	0.07	212	0.403	0	0	\$0.00	NO	\$0.00	YES	\$372.00
12	0.78	3132	0.15	461	0.876	0	0	\$0.00	NO	\$0.00	YES	\$372.00
13	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
4a	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14b	0.62	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	1.08	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.37	3132	0.07	219	0.416	0	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	114.97		3.17357	15020.62	28.53918	0	21 5	8,319.57		\$1,171.98		6.324.00
				Total \$ Exp		15,815.55						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

#### **ECC15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92 DATE:

FILE: 170LITE.WK3

PREPARED BY: JW CHECKED BY: CEL

**BUILDING NUMBER:** 

Sheet 1 of 2

% Unnoc. lights:

19%

Gas Increase Factor 1.68E-04 MBtu/kWh

Cooling Factor (Ene 1.145

									Cost of	Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours 'On'	kW/Month	kWh	Increase	Total kWh	New	Switches	for Well	Sensor	for Ceiling	Sensor
Na.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/y	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
1	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.15	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
28	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.93	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	1.34	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
29	0.53	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
25	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	5475	0.00	46	0.008	53	1	\$396.17	NO	\$0,00	NO	\$0.00
22	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.62	5475	0.00	162	0.027	185	2	\$792.34	NO	\$0.00	NO	\$0.00
14	0.45	5475	0.00	116	0.019	132	1	\$396.17	NO	\$0.00	NO	\$0.00
3	0.53	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
30	1.08	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
31	0.47	5475	0.00	0	0.000	0			NO	\$0.00		\$0.00
	0.47				<del></del>		0	\$0.00		<del></del>	NO NO	
34		5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.31	5475	0.00	0	0.000		0	\$0.00	NO	\$0.00	NO	\$0.00
38	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
41	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
40	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
55	0.93	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
53	1.08	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.27	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
61	0.18	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
69	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
81	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
80	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
72	0.16	5475	0.00	0		0	0	<del></del>	NO	\$0.00	NO	\$0.00
73	0.16	5475	0.03	161	0.027	185	0	+	YES	\$65.11	NO	\$0.00
				900.2585				1		\$260.44		1 1 1 1 1 1

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

#### **ECC15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 170LITI

170LITE.WK3

PREPARED BY:

JW CEL

CHECKED BY:

Sheet 2 of 2

#### **BUILDING NUMBER:**

% Unnoc. lights:

19%

170

Gas Increase Factor 1.30E-03 MBtu/kWh

Cooling Factor (Ene 1.16

									Cost of	Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours *On*		kWh	Increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/y	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
74	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
52	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
43	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
44	0.16	5475	0.00	0	0.000	0	0_	\$0.00	NO	\$0.00	NO	\$0.00
45	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.16	5475	0.00	0	0.000	0	0_	\$0.00	NO	\$0.00	NO	\$0.00
47	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	5475	0.06	322	0.054	369	0	\$0.00	YES	\$65.11	NO	\$0.00
103	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
104	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
106	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
108	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
109	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
110	0.27	5475	0.05	278	0.047	318	0	\$0.00	YES	\$65.11	NO	\$0.00
111	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
112	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
116	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
118	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
119	0.15	5475	0.03	156	0.026	179	0	\$0.00	YES	\$65.11	NO	\$0.00
120	0.93	5475	0.18	967	0.163	1108	0	\$0.00	NO	\$0.00	YES	\$372.00
122	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
119A	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
HALL-	0.62	5475	0.00	0	0.000	.0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.18	5475	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.27	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121-1	2.79	5475	0.53	2902	0.488	3323	0	\$0.00	NO	\$0.00	YES	\$372.00
140-1	0.78	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
154	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
145	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
146	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
147	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
148	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
150	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
149	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
153	0.31	5475	0.06	322	0.054	369	0	\$0.00	YES	\$65.11	NO	\$0.00
Total	28.931		1.44761	8249.625	1.38594	9445.82	4	\$1,584.68		\$1,562.64		\$744.00
				Total \$ Ex	pense =	\$3,891.32						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: 213LITE.wk3
PREPARED BY: JW

CHECKED BY: CEL

EXIT SIGNS:

**BUILDING NUMBER: 213** 

Sheet 1 of 3

 Schedule #1
 M-F
 600 to
 1900
 S-S
 0 to
 0

 Schedule #2
 M-F
 0 to
 0
 S-S
 0 to
 0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of	Unocc. Lights
No.	Fixtures		Survey	Yes/No	Sensor	Switches	On
7	8	4x2-2 lamp fluorescent	on	yes	no	1	по
24		4x2-4 lamp fluorescent	on	yes	по	1	по
24	8		on	yes	no	1	no
8	+	4x2-2 lamp fluorescent	on	yes	yes	1	no
12	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
Recption		4x2-4 lamp fluorescent	on	yes	yes	1	no
7	12	4x2-4 lamp fluorescent	on	yes	no	2	no
88	2		on	yes	по	1	по
9	3		on	yes	no	1	no
13	5	4x2-4 lamp fluorescent	on	yes	по	1	yes
11	- 6		on	yes	no	1	по
12	6	·· · · · · · · · · · · · · · · · ·	on	yes	no	1	по
17	6	4x2-4 lamp fluorescent	on	yes	no	1	no
21	3	4x2-4 lamp fluorescent	on	yes	no	1	по
23	2	4x2-2 lamp fluorescent	off	yes	no	1	по
19	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
20	3	4x2-4 lamp fluorescent	on	yes	no	1	по
22	2	4x2-2 lamp fluorescent	off	yes	no	1	no
67	11	4x2-4 lamp fluorescent	on	yes	по	2	по
70	2	4x2-2 lamp fluorescent	on	yes	по	1	no
77	4	4x2-2 lamp fluorescent	on	yes	по	1	yes
77	9		on	yes	no	1	yes
71	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
72	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
73	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
75	8	4x2-4 lamp fluorescent	on	yes	по	1	yes
74	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
76	19	4x2-2 lamp fluorescent	оп	yes	по	1	yes
Photolab	14	4x2-2 lamp fluorescent	on	yes	по	2	no
93	4	4x2-4 lamp fluorescent	off	yes	no	1	по
96	1	4x2-4 lamp fluorescent	off	yes	no	1	по
97	1	4x2-4 lamp fluorescent	off	yes	no	1	по
Microlab	1	4x2-4 lamp fluorescent	off	yes	no	1	no
98	2	4x2-4 lamp fluorescent	off	yes	no	1	по
100	16	4x2-4 lamp fluorescent	on	yes	по	4	no
35	1	4x2-2 lamp fluorescent	off	yes	no	1	no
Chem.Rm	1	4x2-4 lamp fluorescent	on	yes	no	1	no
91	2	4x2-4 lamp fluorescent	on	yes	no	1	по
79	2	4x2-4 lamp fluorescent	on	yes	по	1	по
78	3	4x2-4 lamp fluorescent	on	yes	по	2	no
108	4	4x2-4 lamp fluorescent	ОП	yes	no	2	по
107	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
109	2	4x2-4 lamp fluorescent	off	yes	no	1	по
110	3	4x2-4 lamp fluorescent	оп	yes	no	1	no
106	2	4x2-4 lamp fluorescent	оп	yes	по	1	по

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

213LITE.wk3 PREPARED BY: CHECKED BY:

JW CEL

**BUILDING NUMBER:** 

213

Sheet 2 of 3

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	S-S	0 to	0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	Na. of	Unocc. Lights
Na.	Lights		Survey	Yes/No	Sensor	Switches	On
104	2		on	yes	по	1	no
102	2	4x2-4 lamp fluorescent	on	yes	по	1	no
101	1	4x2-2 lamp fluorescent	on	yes	no	1	no
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	ves
64	20	4x2-4 lamp fluorescent	on	yes	no	1	no
59	5	4x2-4 lamp fluorescent	off	yes	no	1	no
Footwear	3	4x2-4 lamp fluorescent	off	yes	no	1	по
Laser Rm	3	4x2-4 lamp fluorescent	off	yes	no	1	по
Auto Rm	6	· · · · · · · · · · · · · · · · · · ·	off	yes	no	1	no
111	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
111	3		on	yes	по	1	yes
113		2x2-2 U-Bulb fluorescent	off	yes	ves	1	no
114		2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
116	<del></del>	2x2-2 U-Bulb fluorescent	on	yes	по	<u> </u>	no
117		4x2-4 lamp fluorescent	on	yes	no	2	yes
117		2x2-2 U-Bulb fluorescent	оп	yes	no	2	yes
119	3	process and the second	оп	yes	no	1	no
121	9		on		no	1	no
122	6		on	yes yes	no	1	no
123	21		on	yes	no	5	no
125	2	·	on	yes	no	1	Ves
125	1		off	yes	no	1	yes
127		4x2-4 lamp fluorescent	on	yes	no	1	yes
127	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
128	3	8'-2 lamp fluorescent	off	yes	по	1	no
129	5		on	yes	no	6	Ves
129	12		on	yes	no	6	yes
103	3		on	yes	yes	1	yes Yes
104	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
102	4	4x2-4 lamp fluorescent	on	· · · · · · · · · · · · · · · · · · ·	no	1	yes
102		La dia dia dia dia dia dia dia dia dia di		yes		1	<del></del>
105	2	4x2-4 lamp fluorescent	on	yes	yes		no
	12	4x2-4 lamp fluorescent	on	yes	no	2	no
109	6	4x2-4 lamp fluorescent	off	yes	no	2	no
110	10	4x2-2 lamp fluorescent	off	yes	no	1	no
112	10	4x2-4 lamp fluorescent	on	yes	no	2	no
115	14		on	yes	no	2	no
115	2	2x2-2 U-Bulb fluorescent	on	yes	no	2	no
118	4	2x2-2 U-Bulb fluorescent	on	yes	уөз	1	по
120	9	4x2-4 lamp fluorescent	on	yes	no	2	по
124	14		on	yes	по	1	no
126	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	ПО
129	32	4x2-4 lamp fluorescent	on	yes	no	1	по
58	4	2x2-2 U-Bulb fluorescent	on	yes	по	1	yes
56	4	4x2-4 lamp fluorescent	on	yes	no	1	no
55	2	4x2-4 lamp fluorescent	on	yes	ПО	1	по
Clean-up	2	4x2-4 lamp fluorescent	on	yes	по	1	уев
62	4	4x2-4 lamp fluorescent	on	yes	no	1	по

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 21:

213LITE.wk3

PREPARED BY: CHECKED BY: JW CEL

**BUILDING NUMBER:** 

213

Sheet 3 of 3

 Schedule #1
 M-F
 600 to
 1900 S-S
 0 to
 0

 Schedule #2
 M-F
 0 to
 0 S-S
 0 to
 0

			On/Off		Good For		Unocc.
Room	# of	Fixture Description	During	Switch	Occup.	Na. of	Lights
No.	Fixtures		Survey	Yes/No	Sensor	Switches	On
52	2	4x2-4 lamp fluorescent	on	yes	по	1	yes
51	16	4x2-4 lamp fluorescent	on	yes	no	3	по
65	2		on	yes	yes	1	yes
66	2	4x2-4 lamp fluorescent	on	yes	yes	1	по
45	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
48	48	4x2-4 lamp fluorescent	on	yes	no	2	по
48	22	4x2-2 lamp fluorescent	on	yes	no	2	no
42	28		on	yes	no	1	no
42	6		on	yes	no	1	no
79	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
27	13	4x2-4 lamp fluorescent	on	yes	no	2	по
30	2		on	yes	yes	1	по
86	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	по
	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
34	<del></del>	4x2-4 lamp fluorescent	off	yes	no	1	no
37	6	L	on		yes	1	no
38	6	4x2-4 lamp fluorescent 2x2-2 U-Bulb fluorescent	on	yes ves	yes	1	yes
39	2		<del></del>		no	1	по
94	235	<u> </u>	on	yes	yes	1	yes
95	4		on	yes	yes	1	yes
96	1	4x2-2 lamp fluorescent	on	yes		2	yes
97	5		on	yes	no	1	no
98	7	4x2-2 lamp fluorescent	off	yes	по	5	по
99	12		on	yes	no	2	no
99_	1		off	yes	по	1	no
100	1	2x2-2 U-Bulb fluorescent	off	yes	no		
101	1	4x2-2 lamp fluorescent	off	yes	no	1	no
102	4		on	yes	no	2	yes
106	10	4x2-4 lamp fluorescent	on	yes	по	2	no
107	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
66	2	4x2-4 lamp fluorescent	off	yes	no	1	no
46	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
47	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
71	2	4x2-4 lamp fluorescent	on	yes	no	1	по
72	2		off	yes	по	1	no
73	1	4x2-4 lamp fluorescent	off	yes	по	1	no
41	14		on	yes	no	2	no
39	23	4x2-4 lamp fluorescent	on	yes	no	2	no
77	2		off	yes	yes	1	no
32	6	<del></del>	on	yes	yes	2	yes
26	2		on	yes	yes	1	yes
25	2		off	yes	yes	1	no
28	2		on	yes	yes	1	no
<u>20</u> 29	3		on	yes	yes	1	no
29 33	3		on	yes	no	1	no
33	2		off	yes	yes	1	по
			on	yes	по	1	no
90 36	5		off	yes	yes	1	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

# **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 213LITE.wk3

PREPARED BY: JW CHECKED BY: CEL

CHEC

Sheet 1 of 3

BUILDING NUMBER: 213

% Unnoc. lights: 19%

Gas Increase Factor 2.20E-04 MBtu/kWh

Cooling Factor (Energy) 1.19

										Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours "On"	kW/Month	ƙ₩ħ	Increase	Total kWh	New	Switches	for Wall	Sensor	for Cailing	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yı	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
7	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
12	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
10	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
Recption	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
7	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO .	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.09	3393	0.02	57	0.013	68	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	1.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.36	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
72	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
73	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
76	1.69	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Photolab	1.25	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
93	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
97	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Microlab	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Chem.Rr	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
91	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.31	3393	0.00	0	0.000	0	ō	\$0.00	NO	\$0.00	NO	\$0.00
78	0.47	3393	0.00	0	0.000	0	ō	\$0.00	NO	\$0.00	NO	\$0.00
108	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
109	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.31	3333	0,00	1745.122	0.000	<u> </u>	- 0	<b>\$0.00</b>	NO	\$0.00 \$716.21	140	30.09

RROJECT: FORT MCPHERSON & FORT GILLEM EEAP STUDY

**ÉCO:15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 213LITE.wk3

PREPARED BY:

JW CEL

CHECKED BY:

Sheet 2 of 3

# **BUILDING NUMBER:**

213

% Unnoc. lights:

19%

2.20E-04 MBtu/kWh Gas Increase Factor 1.19 Cooling Factor (Energy)

						į			Cost of	Switches		
<b>D</b>	Total kW/Month	Hours "On"	Lighting kW/Month	Lighting kWh	Total Gas	Total kWh	No. of New	New Switches	Suitable for Wall	Wall Sensor	Suitable for Ceiling	Ceiling Sensor
Room	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/y	Saved/Yr		Cost	Sensor	Cost	Sensor	Cost
No. 104	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.03	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
64	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.78	3393	0.00	Ö	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Footwear Laser Rm	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Auto Rm	1.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.20	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
114	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
116	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	3.10	3393	0.00	0	0.000	0	0	\$0.00	<b>N</b> O	\$0.00	NO	\$0.00
117	0.74	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
122	0.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
123	4.41	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
127	0.47	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
127	0.09	3393	0.00	0		0	0	\$0.00	NO	\$0.00		\$0.00
128	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
129	1.05	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
129	1.07	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
103	0.47	3393	0.09	300	0.066	357	0		YES	\$65.11	NO	\$0.00
104	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
102	0.62	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
105	0.31	3393	0.06	200	0.044	238	0		YES	\$65.11		\$0.00
108	1.86	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
109	0.93	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
110	0.89	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
112	1.55	3393	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
115	2.17	3393	0.00	0	0.000	0	0		NO	\$0.00	NO	\$0.00
115	0.18		0.00	0	0.000	0	0		NO	\$0.00		\$0.00
118	0.37	+	0.07	237	0.052	282	0		NO	\$0.00		\$372.00
120	1.40		0.00	0		0	0		NO	\$0.00		\$0.00
124	. 2.17		0.00	0		0			NO	\$0.00		\$0.00
126	0.09			0		0	0	\$0.00	NO	\$0.00		\$0.00
129	4.96			0		0	0			\$0.00		\$0.00
58	0.37					0	0			\$0.00		\$0.00
56	0.62									\$0.00		\$0.00
55	0.31		+				0			\$0.00		\$0.00
Clean – u							<del></del>	\$0.00	NO	\$0.00		\$0.00
Clean – u	0.62							\$0.00	NO	\$0.00		\$0.0
02	0.02		5.50	1611.03		1			T	\$260.44	<u> </u>	<u></u>

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

# **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 213LITE.wk3

PREPARED BY: CHECKED BY:

CEL

# **BUILDING NUMBER:**

213

Sheet 3 of 3

% Unnoc. lights: Gas increase Factor 2.20E-04 MBtu/kWh

Cooling Factor (Energy) 1.19

									Cost of	Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours 'On'	kW/Month	ƙ₩ħ	Increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yi	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
52	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
51	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	2.48	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
66	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
45	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
48	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
48	7.44	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	1.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	4.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.62	3393	0.12	400	0.088	476	0	\$0.00	NO	\$0.00	YES	\$0.00
30	2.02	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
86	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO .	\$0.00
34	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
38	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
94	0.18	3393	0.03	119	0.026	141	0	\$0.00	NO	\$0.00	NO	\$0.00
95	20.92	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.62	3393	0.12	400	0.088	476	0	\$0.00	YES	\$65.11	YES	\$0.00
97	0.09	3393	0.02	57	0.013	68	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	1.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.31	3393	0.00					\$0.00	YES	\$65.11	NO	\$0.00
47	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO NO	\$0.00	NO	\$0.00
71	0.31	3393	0.06	200	0.044	238						
72	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO NO	\$0.00
73	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
41	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO NO	\$0.00
77	3.57	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11		\$0.00
32	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
25	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
28	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
29	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
33	0.47	3393	0.09	300	0.066	357	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.47	3393	0.00	0	0.000	0	0	\$0.00	YES	<b>\$65.11</b>	NO	\$0.00
90	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
36	0.78	3393	0.00	0	0.000	0	0	\$0.00	YES	<b>\$6</b> 5.11	NO	\$0.00
otal	133.2		2.30736				1	\$0.00		\$1,888.19		1,116.00
			T	otal \$ Exp	ense = \$	3.004.19						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

22-Apr-92 DATE:

G400LITE.WK3 FILE:

PREPARED BY:

JW CHECKED BY: CEL

EXIT SIGNS:

48 Sheet 1 of 1

**BUILDING NUMBER:** 

Schedule #2 M-F

400

\_\_\_\_600 to \_\_\_\_1900 S-S \_\_\_\_0 to \_\_\_\_0 S-S 0 to 0 0 to

Room .	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of Switches	Unocc. Lights
No.	Fixtures		Survey	Yes/No	Sensor	1	On
1	51	4x2-2 lamp fluorescent	on	yes	no	6	no
2	6	4x2-2 lamp fluorescent	on	по	yes	1	yes
3	6	4x2-2 lamp fluorescent	on	по	yes	1	yes
4	3		off	yes	yes	1	по
5	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
- 6	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
7	2		off	yes	no	1	no
8	2	4x2-2 lamp fluorescent	on	yes	no	2	yes
9	24		оп	yes	no	3	no
10		8'-2 lamp fluorescent	on	yes	no	2	no
11	2	8'-2 lamp fluorescent	on	yes	yes	1	yes
12	4	8'-2 lamp fluorescent	on	yes	no	1	yes
14	36	120 Watt Incandescent	оп	yes	no	5	no
15	16		on	yes	по	3	yes
16	11	4x2-2 lamp fluorescent	on	yes	по	3	. yes
17	25	150 Watt Incandescent	on	yes	no	2	no
18	6		on	yes	по	1	no
12	7	200 Watt Incandescent	on	yes	no	1	yes
13	<del>                                     </del>	200 Watt Incandescent	on	yes	no	1	yes
13	2	<del></del>	off	yes	по	1	по
13	2		off	yes	no	1	по
19	6		on	yes	no	1	по
17	18		on	yes	no	2	по
17		8'-2 lamp fluorescent	on	yes	по	2	no
20	1	<del></del>	on	yes	yes	1	yes
20	1		on	yes	no	1	yes
21	2		on	yes	yes	1	no
22	2		off	yes	no	1	no
23	2		on	yes	no	1	yes
24	4		off	yes	yes	1	no
25	1		off	yes	по	1	no
25	1	4x2-2 lamp fluorescent	off	yes	по	1	ПО
26	20		on	yes	по	3	yes
27	64		on	yes	no	8	no
28	15		off	yes	no	2	no
<u>2</u> 0	65		off	yes	no	9	no
29	51		off	yes	no	9	no
30	34		on	yes	no	2	yes
12	2		off	yes	no	1	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

# **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G400LITE.WK3 PREPARED BY: JW

CHECKED BY: CEL

Sheet 1 of 1

**BUILDING NUMBER:** 

% Unnoc. lights: Gas Increase Factor

19%

2.10E-03 MBtu/kWh

400

Cooling Factor (Energy) 1.22

										Switches	1.	
Room	Total kW/Month	Hours "On"	Lighting kW/Month	Lighting kWh	Total Gas increase	Total kWh	No. of New	New Switches	Suitable for Wall	Wall Sensor	Sultable for Ceiling	Ceiling Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yi	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
1	4.54	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.53	3393	0.10	139	0.292	169	1	\$396.17	NO	\$0.00	YES	\$372.0
3	0.53	3393	0.10	139	0.292	169	1	\$396.17	NO	\$0.00	YES	\$372.0
4	0.47	3393	0.09	300	0.630	366	0	\$0.00	YES	\$65.11	NO	\$0.0
5	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
6	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
7	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
8	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
9	2.14	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
10	3.15	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
11	0.42	3393	0.08	271	0.569	330	0	\$0.00	YES	\$65.11	NO	\$0.0
12	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	<b>\$0</b> .0
14	4.32	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
15	1.42	3393	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.0
16	0.98	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
17	3.75	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
18	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
12	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
13	0.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
13	0.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
13	0.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
19	1.26	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
17 :	3.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
17	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
20	0.21	3393	0.04	135	0.284	165	0	\$0.00	YES	\$65.11	NO	\$0.0
20	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
21	0.31	3393	0.06	200	0.420	244	0	\$0.00	YES	\$65.11	NO	\$0.0
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
24	0.36	3393	0.07	230	0.482	280	0	\$0.00	NO	\$0.00	YES	\$372.0
25	0.21	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
25	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
26	1.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
27	5.70	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
28	1.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
29	5.79	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
29	10.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
30	5.27	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
12	0.40		0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
otal	64.525	† <u></u>	0.53751	1412.944	2.96718	1723.792	2	\$792.34		\$260.44		\$1,116.0
				Total \$ Ex								

PROJECT: FORT MoPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G401LITE.WK3

PREPARED BY: CHECKED BY: JW CEL

EXIT SIGNS:

20

**BUILDING NUMBER:** 

401

Sheet 1 of 1

Schedule #1	M-F	600 to	1900	s-s	0_to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup Sensor	No. of Switches	Unocc. Lights On
1	11		on	yes	по	3	no
1	1	8'-2 lamp fluorescent	on	no	по	0	no
2	2	120 Watt Incandescent	off	yes	no	2	по
3	1	120 Watt Incandescent	off	yes	по	1	no
4	26	150 Watt Incandescent	on	yes	no	8	по
4	24	200 Watt Incandescent	on	yes	no	9	по
5	8	4x2-2 lamp fluorescent	on	yes	по	1	yes
6	3	75 Watt Incandescent	on	yes	no	2	yes
7	4	75 Watt Incandescent	on	yes	no	1	по
8	2	120 Watt Incandescent	on	yes	no	1	yes
9	6	120 Watt Incandescent	on	yes	no	1	no
10	4	120 Watt Incandescent	off	yes	no	1	no
11	4	75 Watt Incandescent	off	yes	no	1	по
12	6	4x2-2 lamp fluorescent	on	yes	no	1	yes
13	14	8'-2 lamp fluorescent	on	yes	по	3	по
14	38	4x2-2 lamp fluorescent	on	yes	по	4	no
14	12	120 Watt Incandescent	off	yes	no	1	no
15	38	4x2-2 lamp fluorescent	off	yes	no	4	по
15	12		off	no	по	0	по
16		8'-2 lamp fluorescent	on	yes	по	4	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO:15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

246LITE.WK3

PREPARED BY: CEL

CHECKED BY:

**BUILDING NUMBER:** 

246

Sheet 1 of 1

% Unnoc. lights:

19%

Gas Increase Factor 4.40E-04 MBtu/kWh

Cooling Factor (Energ 1.18

									Cost of	Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Sultable	Wali	Suitable	Ceiling
Room	kW/Month	Hours "On"	kW/Month	kWh	Increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yı	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
154	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
153	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
152	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
151	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
155	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
103	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
107	8.99	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
148	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
147	3.41	3393	0.65	2198	0.967	2594	0	\$0.00	NO	\$0.00	YES	\$372.00
149	0.16	3393	0.03	100	0.044	118	0	\$0.00	YES	\$65.11	NO	\$0.00
146	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
144	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
143	0.93	3393	0.18	600	0.264	707	0	\$0.00	NO	\$0.00	YES	\$372.00
142	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
141	0.36	3393	0.07	230	0.101	271	0	\$0.00	NO	\$0.00	YES	\$372.00
136	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
139	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
138	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
109	4.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.78	3393	0.15	500	0.220	590	0	\$0.00	NO	\$0.00	YES	\$372.00
111	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
116	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
124	5.27	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
120	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
122	0.16	3393	0.03	100	0.044	118	0	\$0.00	YES	\$65.11	NO	\$0.00
123	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
125	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
126	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
134	3.72	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
133	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
132	0.47	3393	0.09	300	0.132	354	0	\$0.00	YES	\$65.11	NO	\$0.00
131	0.47	3393	0.09	300	0.132	354	0	\$0.00	YES	\$65.11	NO	\$0.00
130	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
128	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	51.106		2.09969	7124.248	3.13467	8406.613	0	\$0.00		\$520.88		\$3,348.00
Total \$ 5	Saved/Year	\$199.64		Total \$ Exp	ense = \$	3,868.88						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

# **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: G401LITE.WK3 PREPARED BY:

CHECKED BY:

JW CEL

**BUILDING NUMBER:** 401

% Unnoc. lights:

 % Unnoc. lights:
 19%

 Gas Increase Factor
 2.10E - 03
 MBtu/kWh

Cooling Factor (Energy) 1.22

Sheet 1 of 1

									Cost c	f Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours "On"	kW/Mont	kWh	Increase	Total kWh	New	Switches	for Wall	Sensor	for Calling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
1	0.98	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
1 1	0.12	3393	0.00	31	0.066	38	1	\$396.17	NO	\$0.00	NO	\$0.00
2	0.00	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	0.12	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	3.90	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	4.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.23	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
7	0.30	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.72	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.30	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	2.94	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	3.38	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	1.44	3393	0.00	374	0.786	457	2	\$792.34	NO	\$0.00	NO	\$0.00
15	3.38	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	1.44	3393	0.00	374	0.786	457	2	\$792.34	NO	\$0.00	NO	\$0.00
16	4.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	30.214	-	0	780	1.638	951.6	5	\$1,980.85		\$0.00		\$0.00
			1	Total \$ Exp	опъе =	\$1,980.85						

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: 512LTE.WK3

PREPARED BY: CHECKED BY: JW CEL

EXIT SIGNS:

30

**BUILDING NUMBER:** 

512

Sheet 1 of 1

 Schedule #1
 M-F
 600 to
 1900
 S-S
 0 to
 0

 Schedule #2
 M-F
 0 to
 0
 S-S
 0 to
 0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of	Unocc. Lights
No.	Fixtures		Survey	Yes/No	Sensor	Switches	On
1	43	8'-2 lamp fluorescent	on	no	no	0	no
2	4	8'-2 lamp fluorescent	on	yes	yes	1	yes
3	4	8'-2 lamp fluorescent	оп	yes	no	2	no
4	4	8'-2 lamp fluorescent	on	no	no	0	по
4	4	4x2-4 lamp fluorescent	on	yes	no	2	по
5	12	4x2-4 lamp fluorescent	оп	yes	по	2	no
1	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
6	67	8'-2 lamp fluorescent	on	по	по	0	no
7	3	8'-2 lamp fluorescent	on	yes	no	1	yes
8	3		on	yes	no	1	no
9	1	4x2-4 lamp fluorescent	on	yes	no	1	no
10	1	4x2-4 lamp fluorescent	on	yes	по	1	yes
11	70	8'-2 lamp fluorescent	оп	no	no	0	no
11	1	4x2-2 lamp fluorescent	on	yes	по	1	yes
12	106	8'-2 lamp fluorescent	on	no	по	0	no
12		4x2-4 lamp fluorescent	оп	no	по	0	no
12	6	4x2-4 lamp fluorescent	off	no	no	0	no
13	4	8'-2 lamp fluorescent	on	yes	no	1	no
14	2		on	yes	no	1	yes
15	22	8'-2 lamp fluorescent	on	no	no	0	yes
16	23		on	yes	no	3	no
17	44	4x2-2 lamp fluorescent	on	no	по	0	по
18	9		on	yes	no	6	yes
19	4		on	yes	yes	1	yes
11	6		off	no	no	0	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

# **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 512LITE.WK3

PREPARED BY: CHECKED BY:

JW CEL

**BUILDING NUMBER:** 

ER: <u>512</u>

 % Unnoc. lights:
 19%

 Gas Increase Factor
 4.13E-04 MBtu/kWh

 Cooling Factor (Energy)
 0

Sheet 1 of 1

									Cost of	Switches	- 1	
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	9.03	3393	0.00	2348	0.970	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
2	0.84	3393	0.16	542	0.224	0	0	\$0.00	NO	\$0.00	YES	\$372.00
3	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.84	3393	0.00	218	0.090	0	1	\$396.17	NO	\$0.00	NO	\$0.00
4	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
1	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	14.07	3393	0.00	3658	1.511	0	12	\$4,754.04	NO	\$0.00	NO	\$0.00
7	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	14.70	3393	0.00	3822	1.578	0	12	\$4,754.04	NO	\$0.00	NO	\$0.00
11	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	22.26	3393	0.00	5788	2.390	0	18	\$7,131.06	NO	\$0.00	NO	\$0.00
12	0.78	3393	0.00	202	0.083	0	1	\$396.17	NO	\$0.00	NO	\$0.00
12	0.93	3393	0.00	242	0.100	0	1	\$396.17	NO	\$0.00	NO	\$0.00
13	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	4.62	3393	0.00	1201	0.496	0	4	\$1,584.68	NO	\$0.00	NO	\$0.00
16	2.05	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	3.92	3393	0.00	1018	0.421	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
18	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.84	3393	0.16	542	0.224	0	0	\$0.00	NO	\$0.00	YES	\$372.00
11	0.53	3393	0.00	139	0.057	0	1	\$396.17	NO	\$0.00	NO	\$0.00
otal	82.531		0.3192	19718.55	8.14376	0	66	\$26,147,22		\$0.00		\$744.00

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: 935LITE.WK3

PREPARED BY: CHECKED BY: JW CEL

EXIT SIGNS:

8

**BUILDING NUMBER:** 

935

Sheet 1 of 1

Schedule #1	M-F	600 to	2100 S-S	0_to	0
Schedule #2		0 to	0 S-S	0 to	0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unoca. Lights On
1	36	400 Watt Incandescent	on	yes	no	1	no
2	6	400 Watt Incandescent	on	yes	no	1	по
3	6	400 Watt Incandescent	on	yes	no	1	по
4	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
<u>·</u>	I	75 Watt Incandescent	on	no	yes	0	yes
- 6	3	4x2-2 lamp fluorescent	on	yes	уөѕ	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
8	1	150 Watt Incandescent	on	yes	yes	1	yes
9	9	4x2-2 lamp fluorescent	on	yes	no	2	yes
10	8	,	on	yes	yes	2	yes
2a	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
11	9	· · · · · · · · · · · · · · · · · · ·	on	yes	yes	2	yes
13	4		on	yes	no	11	yes
14	4	<del> </del>	on	yes	yes	1	no
15	+	4x2-2 lamp fluorescent	off	yes	no	11_	yes
16	3	t	on	yes	no	2	yes
17	30		on	yes	no	3	no
18	15		off	yes	yes	3	no
19	10		off	yes	yes	2	по

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO:15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

935LITE.WK3

PREPARED BY:

JW

CHECKED BY:

CEL

**BUILDING NUMBER:** % Unnoc. lights:

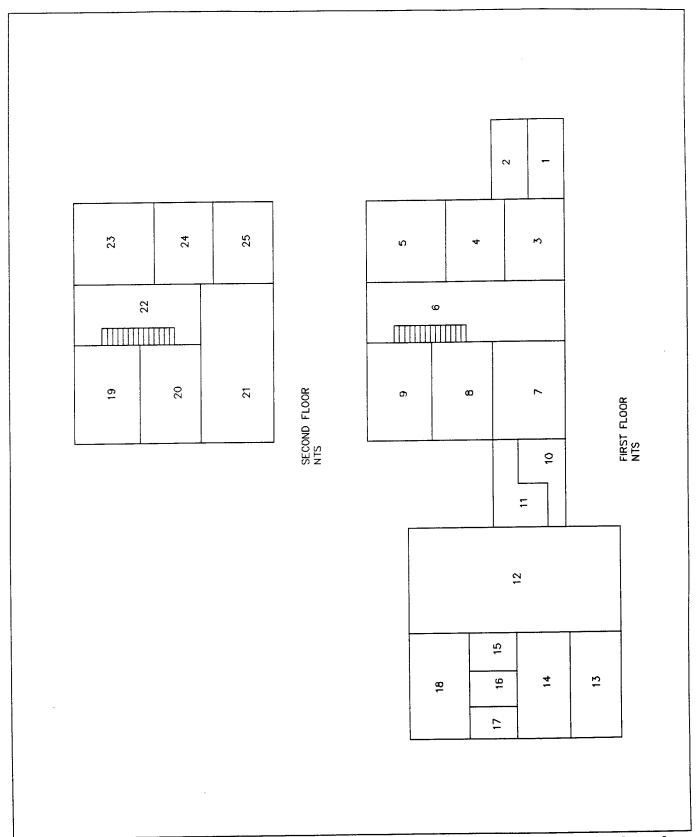
935

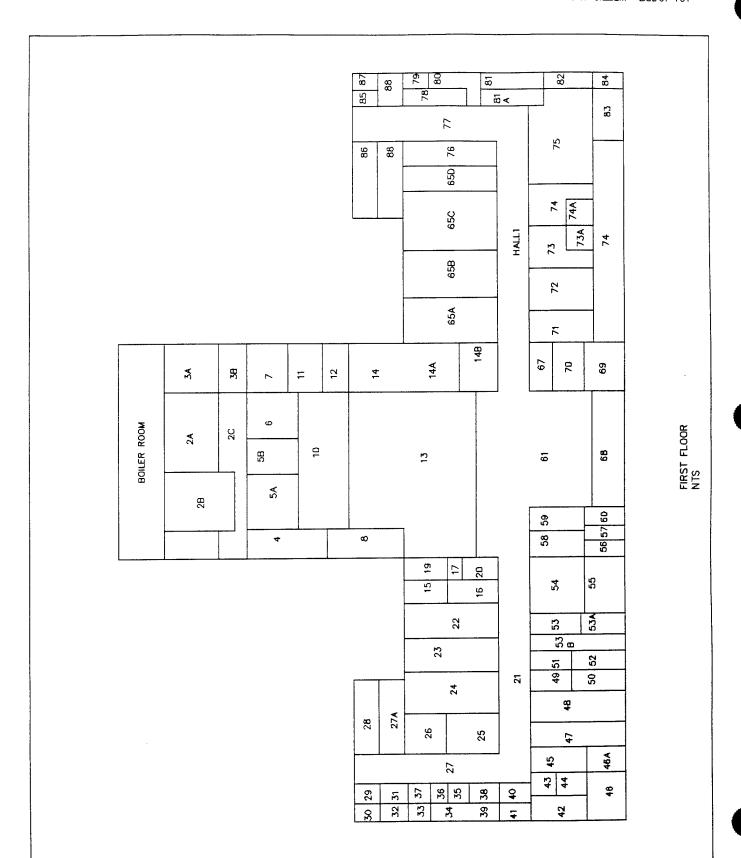
Sheet 1 of 1

Gas Increase Factor 1.27E-03 MBtu/kWh

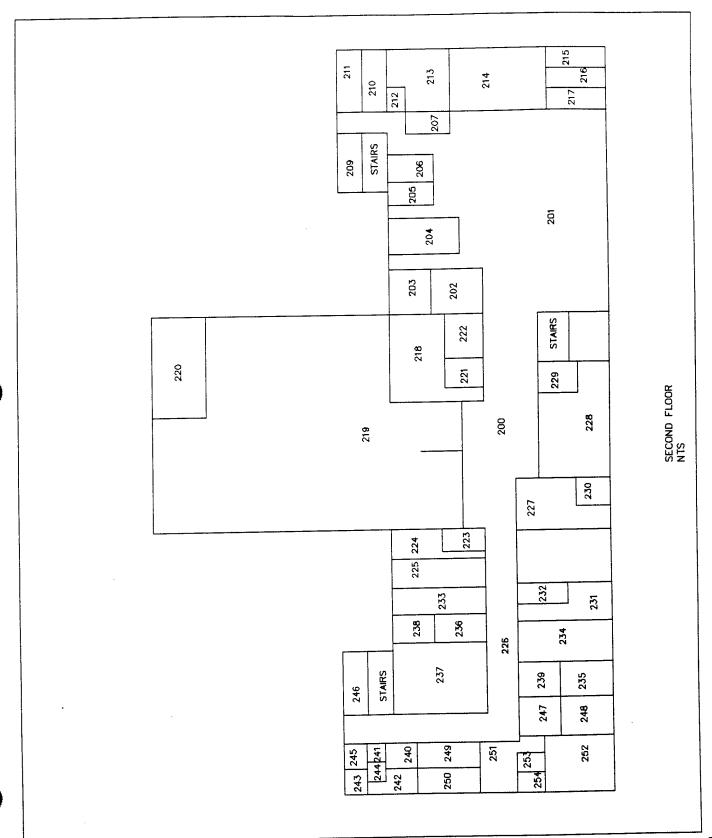
Cooling Factor (Energy) 1.3375

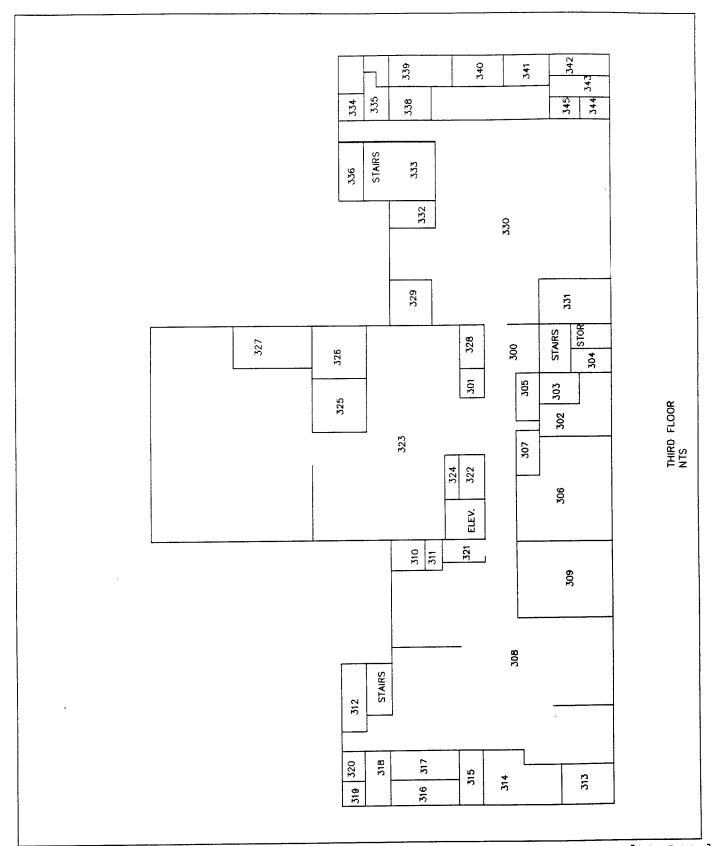
								1 4	Cost of	Switches		
	Total		Lighting	Lighting	Total Gas	,	No. of	New	Suitable	Wall	Suitable	Ceiling
Room	kW/Month	Hours "On"	;	kWh	increase	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yi	Seved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
1	14.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	. NO	\$0.00
2	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	30,00	NO	\$0.00
4	0.31	3915	0.06	81	0.102	108	1	\$396.17	YES	<b>\$95.11</b>	NO	\$0.00
5	0.15	3915	0.03	39	0.050	52	1	\$396.17	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
8	0.15	3915	0.03	112	0.142	149	0	\$0.00	YES	\$65.11	NO	\$0.00
9	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	1.20		0.23	893	1.134	1194	0	\$0.00	NO	\$0.00	YES	\$372.00
2a	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	<b>\$6</b> 5.11	NO	\$0.00
11	0.80	3915	0.15	596	0.757	797	0	\$0.00	NO	\$0.00	YES	\$372.00
13	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.62	3915	0.12	461	0.586	617	0	\$0.00	NO	\$0.00	YES	\$372.00
15	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	2.67	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	1.34	3915	0.25	993	1.261	1328	0	\$0.00	NO	\$0.00	YES	\$372.00
19	0.89	3915	0.17	662	0.841	885	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	30.351		1.23956	4630.306	5.88049	6193.035	2	\$792.34		\$455.77	<u> </u>	\$1,860.00
				Total \$ Ex	pense =	\$3,108.11						

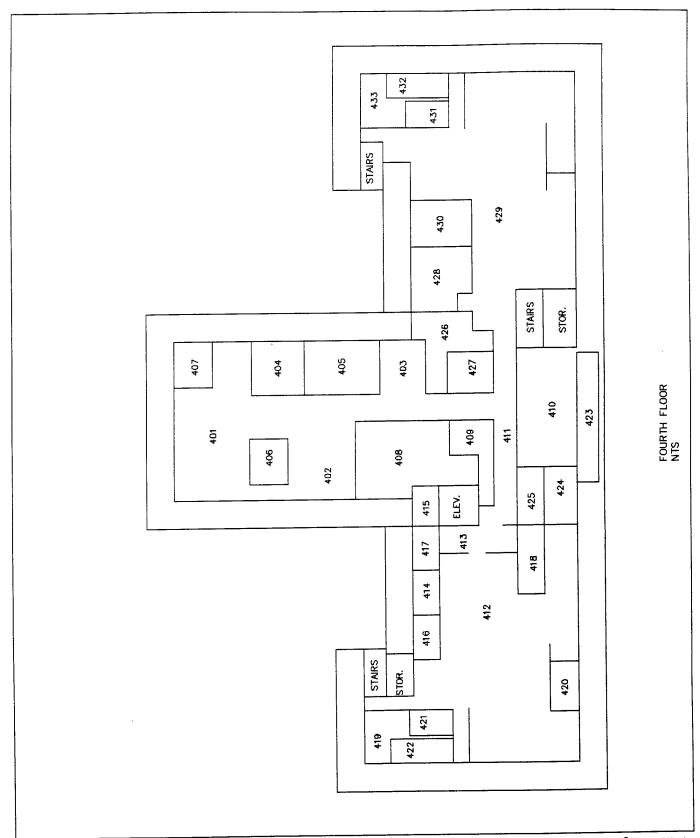


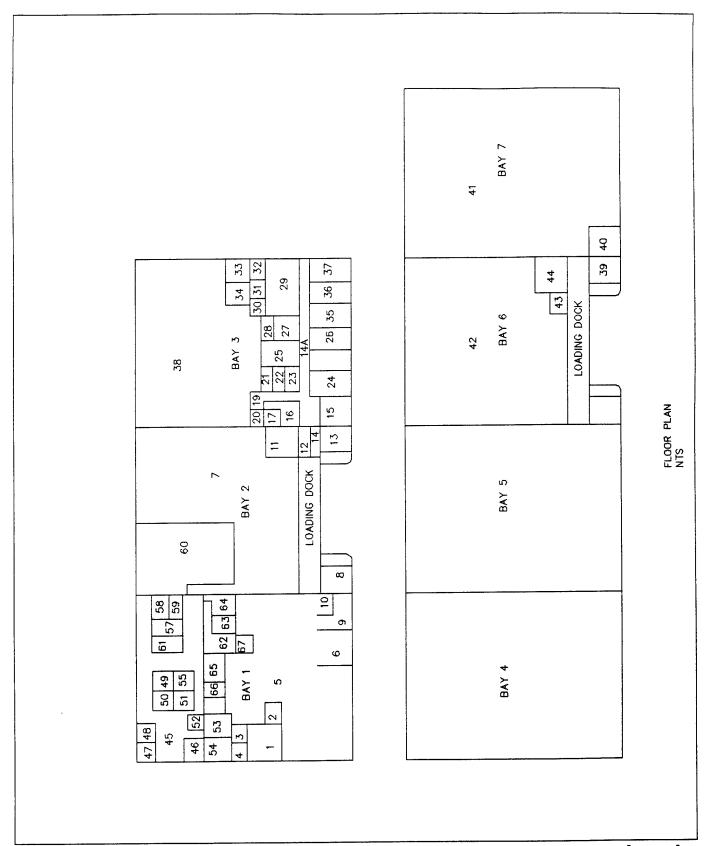


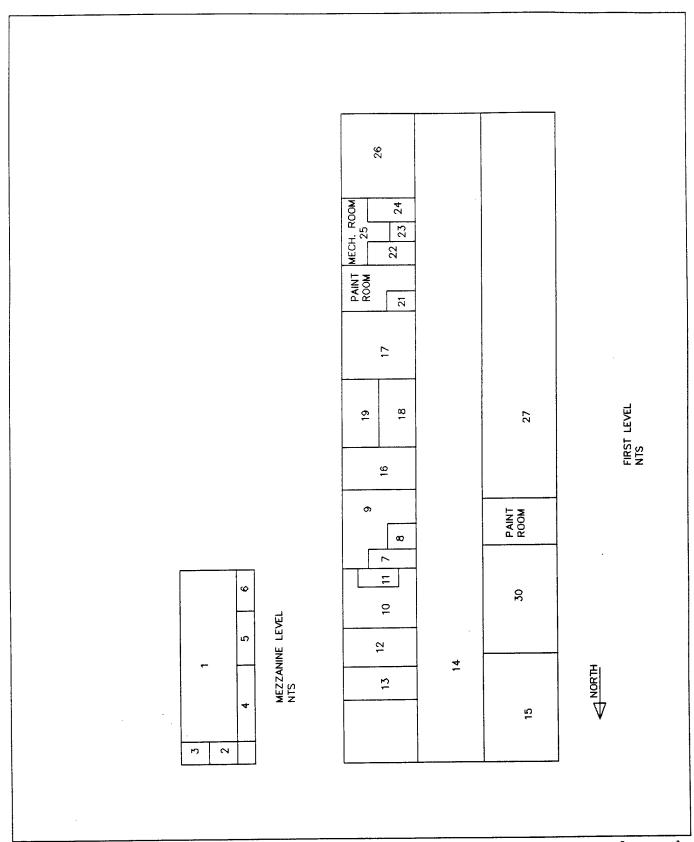
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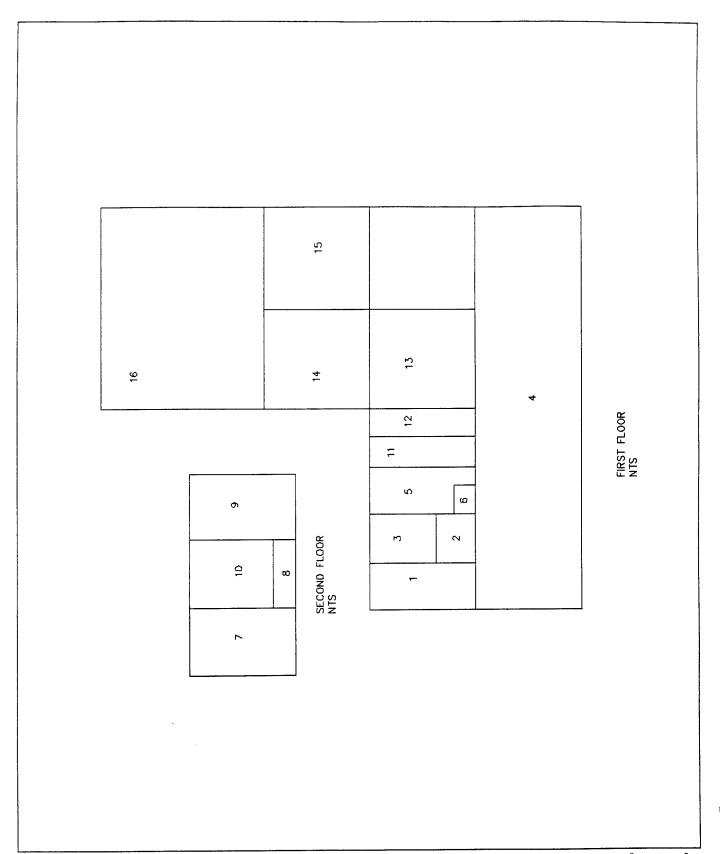






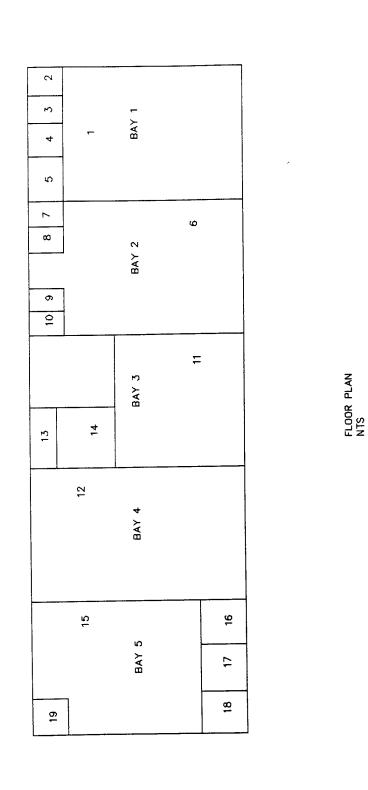




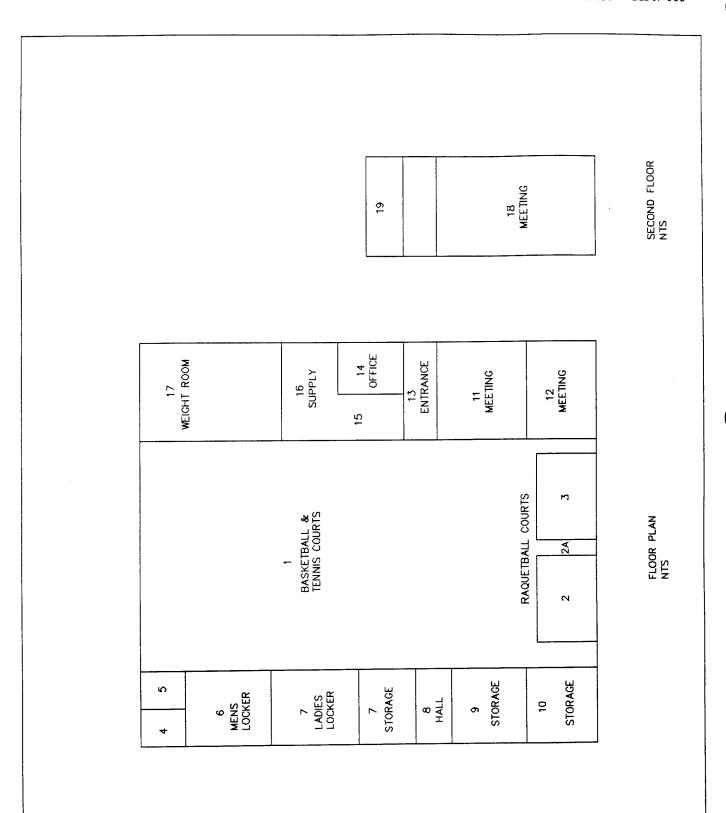


[G401.DWG]

EMC PROJECT # 3105.000 SHEET \_\_\_ OF \_\_\_ FT. GILLEM BLDG. 512



[512.DWG]



# APPENDIX C-16 INVESTIGATE POST DEMAND USAGE

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

CO:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: DUCTPIPE.WK3

PREPARED BY: CAMERAN DIBA

CHECKED BY:

# FORT GILLEM ELECTRICAL DEMAND

								and a contract of the second	AYERAGE	Madder Palace
ECIMAL TIME		1/19/91	1/20/91	1/21/91	1/22/91	1/23/91	1/24/91	1/25/91	MEEKDAY	MEEKEN
COMPL II	0.5	2227	2227	2179	2314	2506	2362	2246	2227	2321
	1.0	2227	2227	2179	2304	2486	2323	2237	2227	2305
	1.5	2246	2227	2179	2304	2496	2342	2246	2236.5	2313
	2.0	2208	2218	2170	2323	2515	2314	2246	2213	2313
	2.5	2227	2198	2160	2342	2477	2314	2237	2212.5	230
	3.0	2198	2179	2150	2323	2467	2314	2227	2188.5	2296
	3.5	2218	2179	2112	2333	2515	2323	2208	2198.5	2298
	4.0	2179	2179	2112	2323	2467	2294	2208	2179	2280
	4.5	2227	2189	2131	2352	2534	2362	2246	2208	23
		2237	2179	2170	2496	2621	2496	2371	2208	2430
	5.0	2342	2189	2170	2746	2832	2621	2669	2265.5	260
	5.5		2198	2189	2880	2880	2717	2861	2376	270
	6.0	2554		2198	3360	3274	3101	3274	2548.5	304
	6.5	2899	2198	2227	4166	4224	4118	4090	2764.5	37
	7.0	3331	2198	2246	4867	4906	4771	4694	2822.5	429
	7.5	3427	2218		5232	5194	5107	4925	2851.5	453
	8.0	3466	2237	2218	5347	5251	5174	5050	<del> </del>	
	8.5	3494	2246	2227		5318	5270	5117		466
	9.0	3514	2246	2237	5376	5280	5261	5165	<del></del>	4
	9.5	3571	2294	2256	5443		5270	5155		<del> </del>
	10.0	3581	2304	2227	5434	5290		5174	-	
	10.5	3610	2342	2285	5405	5386	5338	5155	+	
	11.0	3648	2390	2314	5405	5376	5299	5146	<del> </del>	
	11.5	3638	2381	2314	5395	5338	5290			
	12.0	3619	2381	2352	5290	5290	5280	5088		+
	12.5	3466	2400	2352	5299	5290	5299	5059		<del></del>
	13.0	3398	2400	2323	5328	5251	5280	5050	+	<del> </del>
	13.5	3216	2390	2333	5366	5251	5270	5030		+
	14.0	3197	2371	2304	5299	5222	5203	4982		
	14.5	3053	2352	2294	5213	5155	5222	4867		
	15.0	2880	2371	2266	5184	5098	5270	4781		+
	15.5	2851	2333	2285	5165	5050	5155	4790		+
	16.0	2630	2314	2227	4846	4570	4579	4214		
	16.5	2534	2352	2227	4186	4880	3994	3494		
	17.0	2467	2314	2218	3792	3715	3552	3053		
	17.5	2429	2266	2208	3466	3370	3139	2755		
	18.0	2429	2275	2256	3187	3034	3034	2707	2352	<del></del>
	18.5	2419	2304	2352	2976	2890	2957	2698	2361.5	
	19.0	2390	2304	2342	2861	2794	2918	2650	2347	
	19.5	2371	2304	2352	2813	2746	2784	2611	2337.5	5 26
	20.0			2342	2774	2630	2746	2611	2328	3 26
				2342	2707	2602	2755	2554	2323.5	5 2
	20.5	<del></del>	1	2342		2554			2309	25
	21.0			2362	2621	2486			3 2260.5	5 24
	21.5			2285	2573	<u> </u>	<del></del>	· · · · · · · · · · · · · · · · · ·		7 2
	22.0		<del></del>	2352	2592	<u> </u>		+		5 24
	22.5	+			2563	·				
	23.0			2342 2333	2525					
	23.5									

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: DUCTPIPE.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

# FORT GILLEM ELECTRICAL DEMAND

									AVERAGE	AVERAGE
ECIMAL TIME	N. II. 24	1/11/92	1/12/92	1/13/92	1/14/92	1/15/92	1/16/92	1/17/92	WEEKDAY	WEEKEND
	0.5	2266	2160	2045	2112	2438	2429	2477	2300.2	221
	1.0	2237	2179	2006	2122	2381	2419	2477	2281	220
	1.5	2237	2141	2016	2112	2371	2410	2458	2273.4	218
	2.0	2266	2179	2026	2093	2362	2429	2486	2279.2	2222
	2.5	2275	2189	2016	2122	2352	2448	2496	2286.8	
	3.0	2237	2189	2035	2093	2381	2458	2506	2294.6	221
	3.5	2266	2189	1997	2093	2400	2419	2506	2283	2227
	4.0	2294	2170	1997	2074	2410	2486	2582	2309.8	223
	4.5	2275	2170	2006	2102	2410	2496	2544	2311.6	
	5.0	2275	2170	2160	2237	2554	2621	2650	2444.4	
	5.5	2323	2179	2285	2429	2746	2669	2678	2561.4	
	6.0	2563	2179	2467	2582	2842	2746	2803	2688	237
	6.5	2880	2246	2938	2995	3226	3197	3254	3122	256
	7.0	3014	2314	3686	3869	4003	4090	4186	3966.8	266
	7.5	3062	2438	4358	4406	4608	4810	4858	4608	
	8.0	3043	2419	4723	4781	4982	5184	5136	4961.2	273
	8.5	3110	2410	4762	4867	5078	5328	5242		
	9.0	3168	2448	4858	4973	5194	5328	5261	5122.8	
	9.5	3206	2496	4886	5078	5251	5395	5290		
	10.0	3264	2506	4896	5088	5261	5405	5280	5186	
		3254	2506	4848	5078	5213	5386	5222		
	10.5		2515	4810	5098	5213	5395	5242		
	11.0	3216 3197	2515	4771	5088	5184	5434	5232		
	11.5	3130	2486	4810	5098	5155	5386	5174		
	12.0		2477	4800	5107	5155	5328	5126		
	12.5	2755		4762	5098	5088	5309	5078		
	13.0	2707	2448	4762	5050	5059	5318	5040		
	13.5	2669	2448		5069	5040	5290	5021	5034.4	
	14.0	2602		4752		5040	5280	4992		
	14.5	2525	2400		5059 5050	4973	5155	4915		
	15.0	2467	2362			4906	5107	4838		
	15.5	2448	2333		4954	4349	4541	4022		
	16.0	2381	2304	4051	4483			3350		
	16.5	2362	2256	3418	3888	3754	3974 3562	2995		
	17.0	2285	2189	3034	3466	3389				
	17.5	2246	2150	2822	3216		3350 3091	2803 2698		
	18.0	2246	2179	2678	3043					
	18.5	2275	2218		2928	2918	2966	2717		
	19.0	2256	2189		2832		2918	2611		
	19.5	2237	2141	2477	2842	2803	2870	2544		
	20.0		2131		2774			2496		
•	20.5	2227	2131	2304	2736		2822	2486		
	21.0	2218	2122		2688		2707	2477		
	21.5	2179	2093		2659		2640	2410		
	22.0	2170	2064		2515	2621	2602	2400		
	22.5	2160	2054		2467	2621	2592	2381		
	23.0	2179	2056		2458		2534	2381		
	23.5	2170			2467	2506	2496	2362		
	24.0	2170	2035	2083	2448	2448	2467	2323	2353.8	2102

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY



CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000

DATE: 28-JAN-92 FILE: DUCTPIPE.WK3

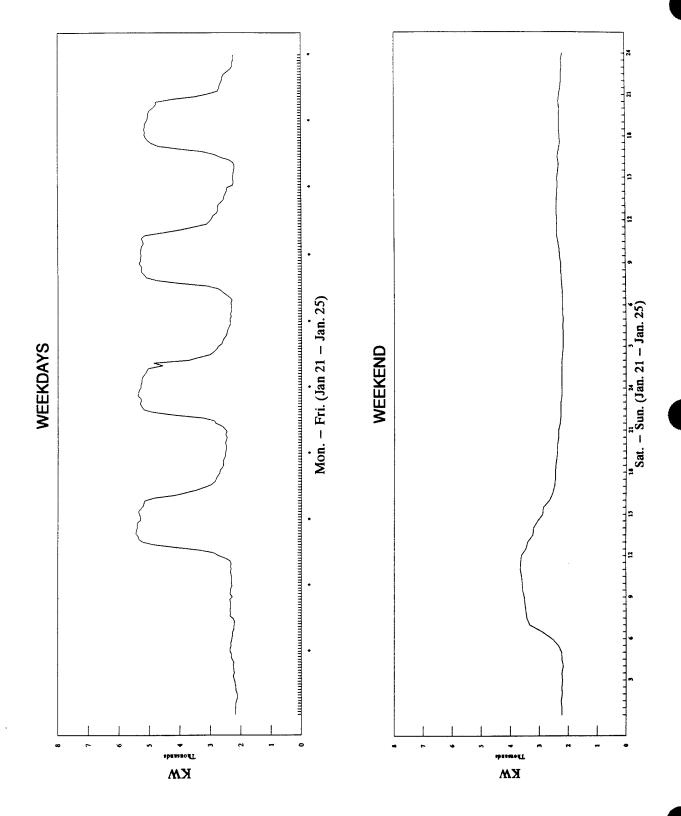
PREPARED BY: CAMERAN DIBA

CHECKED BY:

# FORT GILLEM ELECTRICAL DEMAND

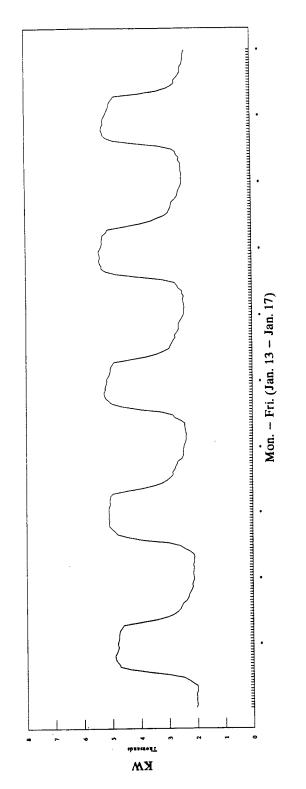
AUGUST 1992			<del></del>				****	AVERAGE	AVERAGE
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0.5	2947	2957	2928	3158	3254	3187	3203 3216	2091.4	2913.5
1.0	2899	2928	2870	3139	3187	3149		2336.55	2870.
1.5	2861	2880	2832	3101	3139	3110	3178	2472.88	2822.5
2.0	2813	2832	2784	3034	3101	3062	3110	2472.00	278
2.5	2755	2813	2813	3053	3139	3082	3101	3066.833	
3.0	2736	2822	2755	3014	3091	3082	3053		
3.5	2765	2765	2746	2976	3043	3005	3043		2745.
4.0	2736	2755	2707	2976	2986	2995	3014		
4.5	2726	2698	2736	2986	2966	3005	3053		
5.0	2698	2698	2822	3072	3062	3110	3158		
5.5	2669	2707	2947	3254	3206	3293	3302		265
6.0	2650	2650	2966	3283	3283	3370	3389		
6.5	2688	2717	3350	3619	3658	3782	3754		
7.0	2726	2678	4253	4483	4502	4646	4493		
7.5	2669	2669	5011	5174	5126	5222	5165		
8.0	2698	2678	5539	5626	5558	5731	5568		
8.5	2832	2765	5798	5942	5808	6019	5933		
9.0	3005	2832	5971	6115	5981	6144	6038		
9.5	3101	2918	6106	6163	6144	6298	6230		
10.0	3197	3043	6134	6307	6202	6403	6307		
10.5	3226	3139	6269	6403	6298	6499	6422		
11.0	3312	3216	6307	6422	6336	6509	6509		
11.5	3350	3264	6442	6566	6480	6566	6442		
12.0	3350	3350	6480	6634	6538	6576	6374		
12.5	3446	3370	6480	6672	6643	6614	6394		
13.0	3485	3427	6528	6768	6653	6672	6480		
13.5	3504	3475	6634	6787	6701	6730	6470		
14.0	3533	3504	6643	6787	6653	6730	6490		
14.5	3542	3590	6710	6835	6672	6768	6528		
15.0	3629	3562	6730	6864	6710	6730	6547		
15.5	3552	3542	6691	6749	6720	6634	6499		
16.0	3562	3504	6086	6115	6192	6067	5693		
16.5	3581	3494	5290	5261	5395	5242	4963		
17.0	3514	3485	4790	4858	4867	4838	4541		
17.5	3494	3418	4502	4560	4637	4560	4291		
18.0	2446	3398	4205	4406	4397	4397	4186		
18.5	3370	3360	4051	4234	4128	4195	3994		
19.0	3264	3302		4022	3965	4090	3734		
19.5	3226	3245		3926	3878	3974	3581		
20.0	3149	3178			3782	3888	3379		0450
20.5	3178			3830	3706	3782	3293		
21.0		3139		3725	3696	3686	3283		
21.5	3178	3158		3590	3571	3610	3178		
22.0	3149	3120			3533		3130		
22.5		3043			3456	3485	308		
23.0		3062		3389	3312		303		
23.5			3283	3322	3283		302		
24.0				3274	3235	3293	294	7 3189.	2 2985

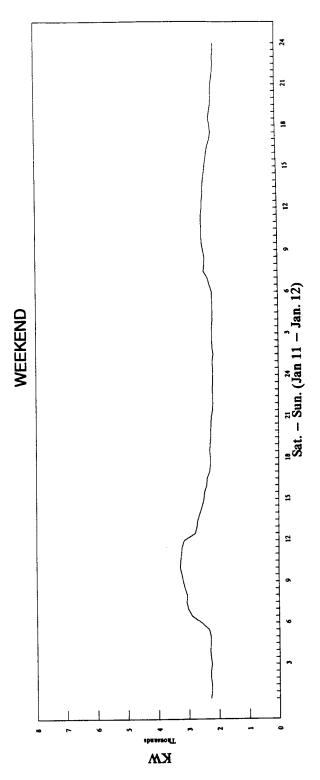
# JANUARY 1991



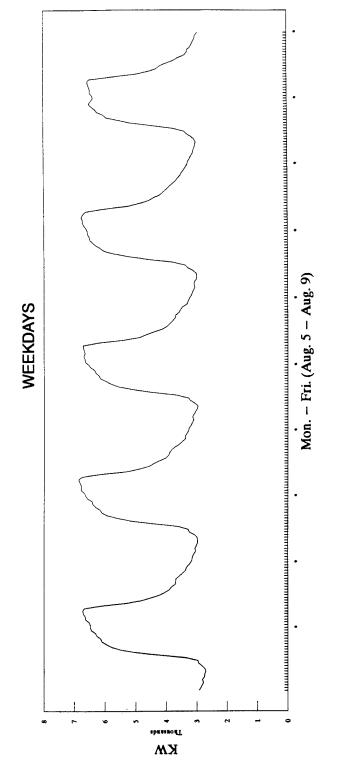
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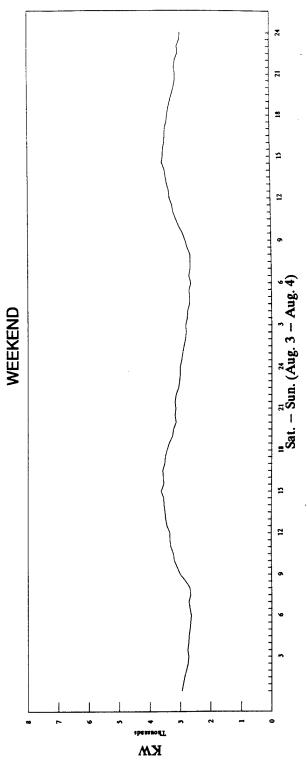
WEEKDAYS





# **AUGUST 1992**





# Scientific Atlanta

Control Systems Division - Box 105038 Atlanta, GA 30348 Telephone 404 441-4000; TWX 810-766 4912, Telex 0542898, ITT 4611081

April 17, 1992

Mr. Carl Lunstrom EMC Engineers, Inc. 1950 Spectrum Circle Suite B-312 Marietta, GA 30067

Dear Carl:

I apologize for the delay in sending you the information you requested recently. We do appreciate your interest in our products, and I really do try to give faster attention to inquiries such as yours. As we discussed, Scientific-Atlanta is a leading manufacturer of radio operated load management systems.

I am enclosing several data sheets to describe a system which would be suitable for Fort McPherson. We can offer a turn-key service to provide and install the head-end equipment, including the transmitter, as well as provide technical support in arranging for installation of the radio switches, which we call DCUs (Digital Control Units). As you know, most military bases would prefer to farm out the labor for installation of these systems.

Budgetary pricing is as follows:

LMC-1041+ Load Management Controller: \$25,000.00
Transmitter and Xtr Controller: \$10,000.00
DCU Radio Switches: \$100.00 ea.
Start up and training: \$4,000.00
Portable Test Unit: \$495.00

I will ask Dick Preston, the regional sales manager for this area, to contact you and provide any further information you may desire. Thanks again for your interest in our products.

Yours truly,

G. Burns Porter

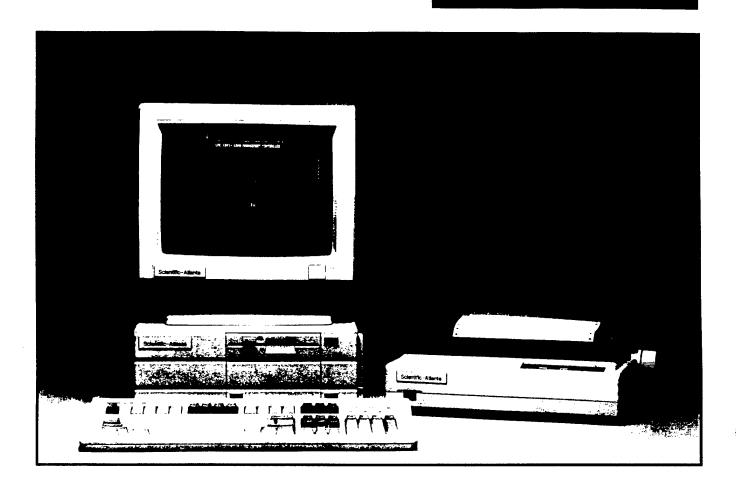
Applications Engineering Manager

GBP/sjb

Enclosures

cc: Dick Preston

# Load Management Controller *Model LMC-1041*+

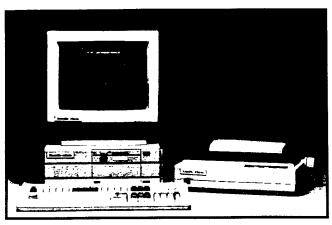


## Features

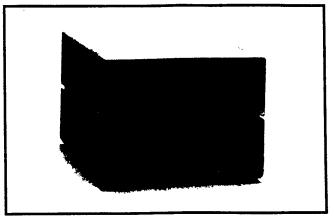
- Combines data acquisition and load control into one machine operating on MS-DOS
- Manual or automatic initiation of load control
- Several load control algorithms are available to the user
- Generates messages in several formats of radio controlled switches
- Program is simple, yet flexible
- Controls air conditioners, water heaters, irrigation pumps, and capacitor banks
- User can define the control "steps" that the program uses
- All programming is done with pop-up menus and operator prompts with on-screen helps
- User defines the number of addresses, number of control groups and strategies he wants and the LMC creates file space to accommodate, limited only by available memory

- Operating characteristics can be modified while the program is running
- Special screens can easily be designed and implemented by the user
- Software supports an optional color monitor
- All software is stored on a hard disk
- Lotus®- compatible historical data files allow easy processing of accumulated data
- Printer can be programmed to automatically print reports
- System automatically restarts in case of power outage
- Interfaces to Scientific-Atlanta's Remote Transmitter Controllers RTC-1032 or RCCA-1002A
- Optional WWV interface ensures accurate timekeeping
- Software supports bar chart and line graphics

# Model LMC-1041+ Load Management Controller



LMC 1041+, Load Management Controller



RTC-1032, Remote Transmitter Controller

# Description

The LMC-1041+ is a personal computer based load management controller and data acquisition system. Automatic or manual control commands are initiated by the LMC-1041+ to remotely installed radio receivers. The receivers control loads such as air conditioners, water heaters, pool pumps, irrigation pumps, etc. Power factor control is also possible by remotely controlling distribution feeder capacitor banks.

Data acquisition capabilities of the LMC-1041+ permit monitoring of substation data for display and/or initiation of automatic control functions. Automatic control can be done using kW or kVAR inputs, status point closures, and/or time-of-day and day-of-week schedules.

Capable of outputting all standard Scientific-Atlanta code formats as well as a number of others, the LMC-1041+'s flexible software permits the user to easily configure the system by selecting the options he wants from the pop-up menus, lists of valid entries, and notes which briefly explain what each entry does.

An unlimited number of load groups as well as multiple load control algorithms, time-of-day schedules and control strategies provide ultimate flexibility. The user can even modify existing displays or create new displays to meet his needs using the LMC-1041+ display editor. With this capability he can display the most important "real-time" and explanatory information.

The LMC-1041+ places no limit on the number of strategies, load groups, or switch addresses the utility may use. The user tells the LMC what he wants to do and the LMC creates file space to meet the user's needs. The only limit is the amount of memory available.

The LMC-1041+ program is organized by strategies, setpoints, status points and time-of-day schedules. The user can then apply these characteristics to increase or decrease the amount and type of load to be shed and restored to meet changing control requirements. The user can call for load control algorithms such as cycling at a designated percentage, on/off control, various dis-

tributed intelligence strategies, nicking or SCRAM. These can be used in virtually any combination to meet the user's control needs.

The LMC-1041+ also has several features which support the user in operating the system and reporting what has happened. All information can be formatted into a Lotus® compatible file and stored on the hard disk. The printer can be programmed to print out any or all events such as alarms or the automatic initiation of load control.

The LMC-1041+ also uses Scientific-Atlanta's Remote Transmitter Controller (RTC-1032) in this system. An RTC-1032 is located at each transmitter site, connected to the LMC through 1200 baud modems. The RTC-1032 (formerly the RCCA-1002A) receives the messages to be broadcast from the LMC, stores those messages until its proper time slot, keys the transmitter, then generates the proper modulation (tones or shifting frequency) to represent the message.

The RTC can generate most of the formats used in load control today. These include single tone, two tone, Scientific-Atlanta's digital, 100, 102, SA-105 and SA-205 AFSK formats, and the Golay 23, 12 FSK format.

The RTC can control up to six groups of transmitters (for time slot coordination with other utilities). If a carrier-operated relay is in the transmitter, the RTC can also wait until the air clears before broadcasting.

The LMC-1041+ is typically quoted with the standard hardware shown in the specifications section. The RTC's and modems are quoted separately because each system may require different numbers of transmitters.

# **Specifications**

# LMC-1041+ Hardware

- Personal computer running on MS-DOS operating system with enhanced keyboard and 640K of RAM
- 13" Color Monitor
- 3 1/2" 720K floppy disk drive
- 20 MB hard disk
- Dot matrix printer
- Serial port
- Parallel port
- Data acquisition board and connector panel with 8 analog inputs, 8 status inputs, and 8 contacts out
- All interfaces and cables required.
- Hardware Options:
  - Up to 24 analog inputs, 24 status inputs, and 24 contacts out

## LMC-1041+ Software

## Load control

### 1. Strategies

- a. Up to 1000 allowed
- One or more running at the same time
- c. Up to 100 load control steps per strategy
- d. Direction of the steps can be changed whether in shed or restore mode
- e. Strategies can be tied to any combination of four status points, analog demands, or time-ofday schedules for automatic initiation of load control
- f. And/or conditionals enhance initiation factors
- g. Strategy activation can be automatic (tied to activation parameters), continuous (constantly active), or in SCRAM mode (to select 100% shed of all points)

### 2. Steps

- Three types of steps (activation of switch groups, closing control points, or resetting strategy activation level to a new point)
- b. Automatic, continuous, or SCRAM activation of any step
- Steps can be linked to make them happen at the same time in either the shed or restore direction.
- d. Information going to the historical data files can be turned on and off

### 3. Switch Group Steps

- a. Switch control algorithms
  - Sequential step (on/off in the same order each time)
  - Rotational step (on/off in rotating order)
  - Gradual time cycle (achieve designated % over one time-out period)

- Fast time cycle (achieve designated % in one burst of messages)
- Target % load shed (responds to changes in demand level)
- Nicking (for testing the effectiveness of load control)
- 102 commands (repeating direct load control)
- SA-105 and SA-205 commands (distributed intelligence control)
- b. Maximum load shed % for this switch group
- Maximum duration of load control for the switch group
- Time that the appliance must remain on after reaching its maximum duration before it can be controlled again
- Time-out, cycle time and number of repetitions selections in the 102, SA-105 and SA-205 format switches.

## 4. Switch Groups

- a. Up to 1000 addresses per group
- b. Group assigned to a single or all transmitters
- Repeat number of messages sent each time (1 or more)
- d. Minimum, nominal, and virtual time-outs

### 5. Addresses

- Individual addresses can be enabled or disabled
- b. Messages sent can be recorded in a data file
- c. Nine different formats are supported (SA timeout, SA set/reset, single tone, two tone, Golay, 100, 102, SA-105 and SA-205)

### 6. Time-of-Day Schedules

- a. Schedule name
- b. Programmed for seven days plus holidays
- c. 4 start/stop intervals per day

### 7. Holiday Lists

a. 20 days

### 8. Transmit Schedule and System Options

- Enable or disable transmissions during each minute of the hour (for coordination with other utilities)
- Time slotting for 1 to 6 transmitter groups (divides the minute into 10 to 60 second time slots)
- c. Carrier busy "listen-before-talk"
- d. Password security
- e. WWV time synchronization

# Specifications (Cont.)

# Data Acquisition

### 1. Remote Terminals

- a. Individually addressable
- b. Polling can be enabled or disabled
- c. Polling interval in one minute increments
- d. Up to 24 status points
- e Up to 24 analog-in points

## 2. Telemetry (analog inputs)

- Default values can be assigned in case of communication failures
- b. Scaling mulitipliers are used
- c. Offsets establish starting points
- d. High and low limits establish use of defaults

### 3. Calculate

- a. Analog values used to calculate demands
- b. Unlimited number of calculations available
- c. 30 different operators can be used

### 4. Demands

- a. Names
- b. Unlimited number
- c. Combines analog inputs in any manner
- d. Demand interval set from 1 to 60 minutes

### 5. Setpoints

- a. User designated initiation factors (kW, kVAR, kVA, temperature, etc.)
- b. User sets shed and restore values
- c. User decides the relationship of the shed and restore values

## 6. Control Points

- a. Name
- b. Up to 24 contacts-out (external)
- c. Unlimited number of internal control points

# Reporting

## 1. Printer

- a. Automatic printing of events (alarms and actions)
- Automatic printout of special screens at designated times

### 2. Display building program

a. Used to develop special, custom-built screens

### 3. Historical Data Files

- a. Name
- b. Captures designated display numbers
- c. Establish interval between captures
- d. Establish file sizes
- e. Reset data by day of the month

### 4. Graphics

- a. Explanatory including lines and boxes
- b. Real time bar and line graphs
- c. User choice of colors, intensity, axes and offsets

### 5. Transmitter Check-Back

a. Error indications from the transmitter sites can alarm at the LMC

## Miscellaneous

- Pop-up bar type menus
- 2. On-screen programmable helps (lists options at each choice)
- 3. Programming is done by filling in the blanks
- 4. Function keys (F1 F12) are user programmed to enact control or call up screens
- 5. A majority of programming characteristics can be changed while the program is running
- 6. Copy configurations to floppy disk
- Automatic testing for illegal parameters and relationships
- Redundant hardware configuration allows automatic transfer between machines in case of failure

# Options

 Communications package to allow a remote computer to query, modify the program, or enact control

## **RTC-1032 Remote Transmitter Controller**

- Input 120V ac. 60 Hz
- Power Consumption 30 watts
- Operating temperature 0°C +50°C
- Control Output 6 SPST contacts, 250V ac, 3A
- Communications Modem 1200 baud, bell 212
- Listen-before-talk contact closure from carrier operated relay in the transmitter with LBT override ( if the channel stays busy)
- Status Input two contact closures

# Typical Load Management Program

Control: Can be enabled or disabled

from this page.

Mode: Allows automatic or manual

operation.

Status: Shows whether control is

active or inactive

Status: Indicates current load control activity (shedding or restoring).

A: The demand level at which load control is initiated.

The demand level at which the program starts restoring the loads.

on a real-time basis.

This screen was "built" by the user from standard information to display the most important information

> Current: Total system demand. High: The high demand (with time) for the current period.

Low: The low demand for

**Duration:** The maximum and current duration of this step

Load Shed-Min and Max:

Sets the limits of load shed percentage for this step.

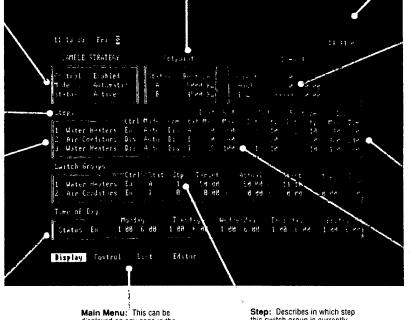
being active.

the current period.

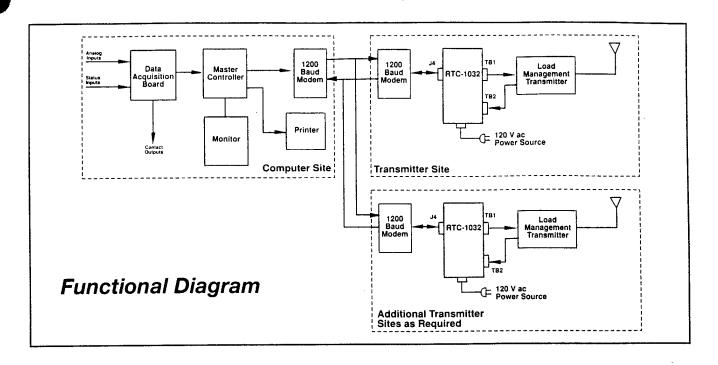
Steps: Define the order of the procedure for controlling load.

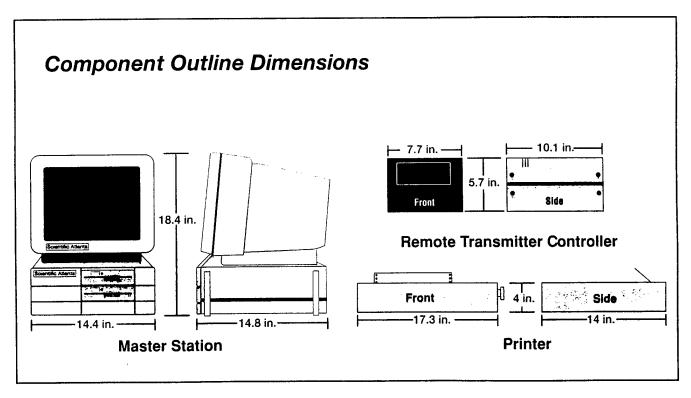
Names: The type of load controlled in each step.

Time of Day: Shows which days and what time of day this strategy can be active (subject to other setpoint demands and/or contact closures).



**Step:** Describes in which step this switch group is currently being used.





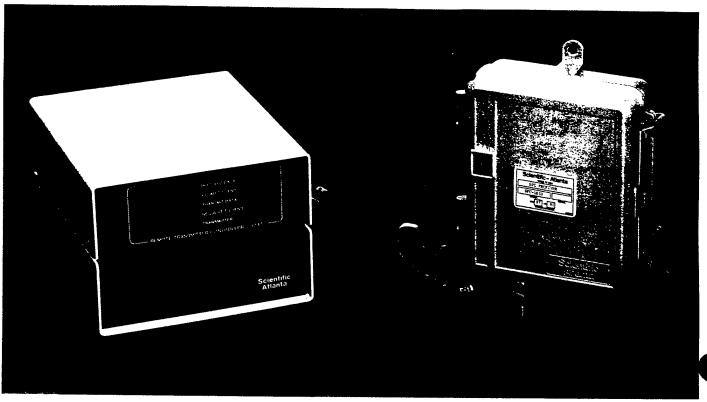
### Scientific-Atlanta, Inc.

"Our Customers are the winners." 404-449-2900

### Scientific Atlanta

Instrumentation Group

# Transmitter Controllers Model RTC-1032/SFC-1033



20118

Generates audio messages received from a master controller to activate load management switches for demand control.

### Features

- Multiple transmitter control (up to six)
- · Capable of seven different VHF message formats
- "Listen-before-talk" option
- · Watchdog circuitry
- · Power fail detect circuit

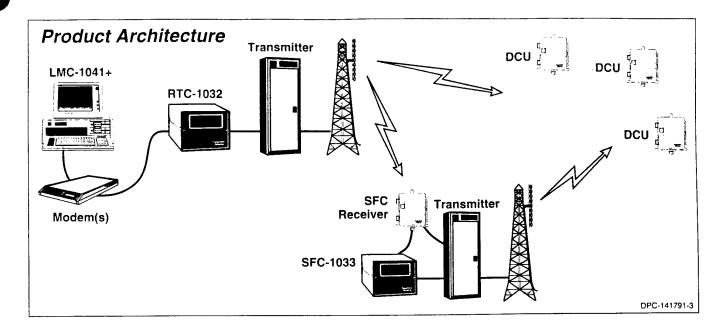
### **Applications**

The RTC-1032 Remote Transmitter Controller is capable of generating messages in any of seven code formats to activate load management switches based on data downloaded from a master controller.

The SFC-1033 Store and Forward Controller is identical to the RTC-1032 and is located adjacent to a repeater. The SFC repeats data it has received via the antenna switch relay circuit located in the repeater.

Scientific-Atlanta, Inc. 404-449-2900 C-16.14

### Transmitter Controllers Model RTC-1032/SFC-1033



### Operation

The RTC-1032 receives load control messages and timing messages from a master controller. The RTC-1032 then generates audio tones representing digital messages and keys the transmitter at the appropriate times. The RTC-1032 is capable of receiving and responding to a contact closure for "listen-before-talk" to make sure the channel is free before transmitting. The RTC-1032 contains watchdog circuitry to eliminate lockups of microprocessors caused by transients and power surges.

Two modes of transmissions are provided when using multiple transmitter control. The "slotted mode" divides the minute into as many as six time slots, so that each RTC-1032 keys each transmitter at the appropriate interval. Where a single RTC-1032 is connected to multiple transmitters, the "contiguous mode" keys the transmitters back-to-back with only key up/key down delays between transmissions.

The SFC-1033 receives load control messages and timing messages via the antenna switch relay circuit located in the repeater. The SFC-1033 buffers the data and retransmits it, acting just like the RTC-1032. The SFC-1033 will generate the digital messages and key the transmitter/repeater at the appropriate times. The SFC-1033 can respond to a contact closure for "listen-before-talk" to make sure the channel is clear before transmitting. The SFC-1033 also contains the watchdog circuitry.

The SFC-1033 can control multiple transmitters located at a central remote location by tieing into just one of the

receivers. Several SFC-1033s can be used within a system but one RTC-1032 is required at the main transmitter.

The RTC/SFC can generate the following formats:

Single-tone SA Digital REMS 100/102 SA-205 Two tone sequential Golay 23.12d SA-105

### Specifications

Enclosure

Aluminum

Size

7.7 in. W x 5.7 in. H x 9.1 in. D

Weight

8.5 lbs.

Shipping weight

10 lbs

Input voltage

120V ac, ±10%, 60 Hz

Power consumption

30W max

Operating temperature

0°C to 50°C, non-condensing

Transmittal keying control

6 "SPST" - Normally opened relays rated at

.5A 125V ac

.6A 110V dc

Specifications subject to change without notice

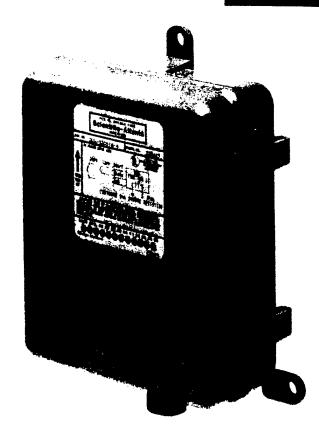
### Ordering Information

RTC-1032 SFC-1033 Remote Transmitter Controller Store and Forward Controller

### Scientific-Atlanta, Inc.

Our customers are the winners.

**Control Systems Division** 



The radio controlled switch interrupts loads, such as air conditioners, water heaters and irrigation pumps, upon command from the utility's master controller for load management.

### Features

- · 4 million individual fixed addresses
- 6 programmable operational addresses per switch can be grouped for divisional, area, substation or feeder control
- · Remote programming via radio message
- Choose from 4,096 programmable, operational addresses
- Distributed intelligence design provides up to 8 hours of control with one message
- Randomized "shed" and "restore" provide smooth, graceful ramping in and out of load control
- High performance dual conversion FM receiver
- · Cold load pickup and cancel
- A record of actions kept in non-volatile memory, accessible by the Portable Counter Display®
- · Fail safe timer reconnects load at the end of the control period
- · Weatherproof, Lexan® enclosure
- Electronics mounted in removable door for easy field maintenance
- · One, two, three or four separate functions

### **Description**

The SA-205 format Digital Control Unit (DCU) is a radio controlled switch designed to switch remote loads on and off in response to commands from a central control. Additionally, each digital control unit may be individually programmed and controlled remotely via radio signals.

Utilizing "distributed intelligence", control for up to eight hours can be accomplished upon the receipt of a single radio command. A smooth transition into as well as out of control is ensured through the use of a unique, linear control algorithm in which each switch independently selects its own start and stop times after receipt of a radio control message.

SA-205 Digital Control Units are available in one, two, three or four function designs. Cold load pickup, a feature which disconnects load when power is restored after an outage, is remotely programmable from 0 to 60 minutes via radio message.

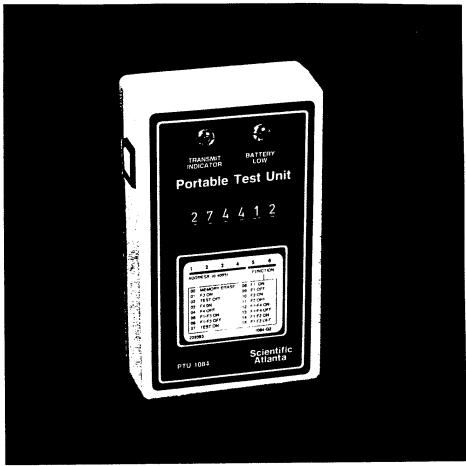
Important data about the DCU's operation, including the number of operations, time since its memory was reset and configuration data, is maintained in the unit's memory. Data can be read with Scientific-Atlanta Portable Counter Display (PCD), without opening the DCU door. The Portable Counter Display transmits a radio signal to the digital control unit which causes the DCU to flash its LEDs in a digital manner. The PCD optically reads the data and displays it on a liquid crystal display.

### Scientific Atlanta

Instrumentation Group

### Portable Test Unit Model **PTU-1084/1085**

A hand-held device that locally exercises the functionality of a Digital Control Unit.



19921

### Features

- · Provides on-site testing of radio controlled switches
- · Available for use with popular FSK and AFSK code formats
- · Powered by replaceable 9V battery
- · Low battery indicator
- · Includes nylon case

### Application

Scientific-Atlanta's PTU-1084/1085 Portable Test Unit is a hand-held, battery operated low output transmitter which permits field testing of Digital Control Units. It allows manual transmission of digital radio signals to test for proper operation of a switch. The economy and portability of the PTU make it practical for each switch to be tested as it is installed.

The PTU-1084/1085 is crystal-controlled and transmits on a customer-specified VHF frequency, between 138 and 174 MHz.

Scientific-Atlanta, Inc. 404-449-2900

C-16.17

### GAS AIR CONDITIONING EQUIPMENT

January 14, 1992

### **ENGINE DRIVEN:**

TECOCHILL: 125, 150tons (165tons w/economizer); Teco Drive 454; screw compressor R22 refrigerant; heat recovery available (250 and 500 ton models in field test)

Mingledorff's: Bruce Longino, 404-446-6311

TRANE: 55, 80 tons; Hercules engine; Trane reciprocating compressor Trane: Jim Gieselman, 404-321-7500

THERMO KING: 15ton, 25ton(Summer 1991); rooftop units; Hercules engine; Thermo King reciprocating compressor; +80% furnace included Split 15ton system available summer 1991

Thermo King Atlanta, Inc.: Harold Haskell, 404-361-4019

ALTURDYNE ENERGY SYSTEMS: 26, 47, 75, 94, 114, 141, 186, 231, 284tons; Reciprocating compressors, industrial grade engines, analogue controls Associated Air Systems, Inc.: Al Schnur, 404-587-0970

### **CUSTOM BUILT:**

Owsley Brothers: Bob Reid, 404-361-1100 650ton; Waukesha engine; York centrifugal compressor; Heat recovery available

Utility Systems Corp.: Richard Nelson, 516-287-3741 250, 400, 550, 665, 800ton; Caterpillar engines, York screw comp. Heat recovery available

### DIRECT FIRED 2-STAGE ABSORPTION: No CFC's!

CARRIER: 100 - 500tons; operates w/59F condenser water Carrier: Shawn Wood, 404-988-0893

McQuay-Sanyo: 20 - 1,500tons; simultaneous heating/cooling optional
Brake & Hegyan (Atlanta): Michael Lawler, 404-455-1954

TRANE: 100,120,150,180,200,240,300,350,400,450,500, up to 1100tons
Units 550tons and smaller can be built for outside installation
Trane: Jim Gieselman, 404-321-7500

YORK: 100,125,140,150,170,200,250,270,320,345,400,430,500 up to 1,500tons-Manufactured by Hitachi; will manufacture in USA York Int'l.: Clint Knudson, 404-925-1002

YAZAKI: 20,30,40,50,60,80,100tons

Atlanta Gas Light Co.: Jim Sullivan, 404-584-3758

Gas A/C Equipment January 14, 1992 Page 2

STEAM FIRED ABSORPTION:

No CFC's !

Two Stage:

CARRIER: 150,250,400,500,600,700,800,1000,1200,1500tons

TRANE: 385-1060tons

Input of 12.2lbs/ton-hr, 123psig steam for rated full load

YORK: 250,270,310,360,400,450,500, up to 1,500tons

Input of 9.9lbs/ton-hr, 114psig steam for rated full load

MCQUAY-SANYO: 100-1500tons

Single Stage:

CARRIER: 70-815tons

Input of 18lbs/ton-hr, 14psig steam for rated full load

TRANE: 101-1,660tons

Input of 18.7lbs/ton-hr, 14psig steam for rated full load

YORK: 120 to 1,400tons

Input of 18.3lbs/ton-hr, 15psig steam for rated full load

**HEAT RECOVERY ABSORPTION:** No CFC's !

YORK: 100,125,140,150,170,200,250,320,345,400,450,500, up to 1,500tons

Uses clean exhaust gas 550-1500F

Option to use engine jacket water heat recovery

### Gas Engine Driven Chiller Systems



### Centrifugal Compressor Line

- 30 to 95% Energy Savings
- Fully Automatic Unattended Operation
- Continuous 20 to 100% Modulation
- Open Drive Compressor
- Hot Water Available
- Remote Diagnostics
- Made in U.S.A.

TECOCHILL centrifugal chillers provide cost effective and reliable chilled water for commercial, industrial and institutional cooling needs. The chillers combine the familiarity of vapor compression refrigeration with the energy efficiency of TecoDrive, a natural gas prime mover. TECOCHILL chillers provide substantial savings over electric and absorption chillers by reducing energy costs 30 to 95%. These savings are due to an exceptionally efficient design, lower utility costs and avoided electric demand charges.

The TECOCHILL CH-500 chiller uses two TecoDrive engines directly coupled to open-drive centrifugal compressors. The TECOCHILL CH-250 chiller uses a single TecoDrive engine. TecoDrive engines have earned a strong reputation for reliability and performance in the HVAC community. This reputation has resulted from millions of hours of operation in chillers and cogeneration modules.

TECOCHILL chillers provide the highest coefficient of performance (COP) of any type of gas chiller. The inherent variable speed capability of the TecoDrive engine and compressor team offers even higher part-load system efficiencies and superior load following capability. Continuous modulation from 20 to 100% provides customers with precisely controlled chilled water temperature.

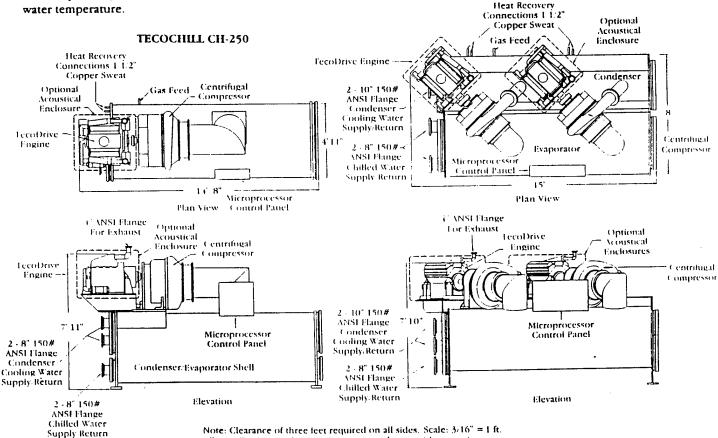
A powerful microprocessor based control system provides fully automatic operation, continuous chiller monitoring, digital display, fault and safety diagnostics and convenient interface to energy management systems in a user-friendly package. These features have resulted in a significant reduction in service costs.

Optional equipment includes a heat recovery package that yields as much as 1,700,000 Btu/hr of hot water which can supplement boilers or other thermal needs. Acoustical enclosures are available that reduce noise level. A remote monitoring and control system is available that permits remote operation and diagnostics via telephone and personal computer.

Made in the USA, TECOCHILL chillers are readily available and serviced by factory-trained local HVAC service professionals. TECOCHILL chillers are equal in size to electric chillers and smaller than absorption chillers. Also, open-drive compressors allow easier conversion to alternate refrigerants in the future. The chiller has been designed for ease of installation and with standard connections.

A cooling system evaluation is no longer complete without a TECO-CHILL comparison. For further information, please contact Tecogen Inc. directly or our local sales representative.

#### TECOCHILL CH-500



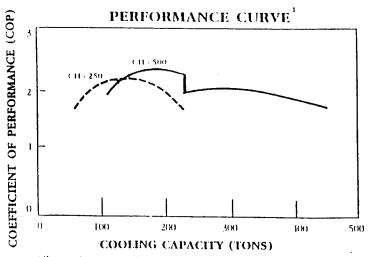
All specifications and materials subject to change without notice.

All specifications and ratings are +5%

G	ENER	۸L	SPEC	HIC	ATIONS
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dodel	CH - 250	CH - 500
	270 230	430
Full load	1.7	1 7
Integrated Part Load Value (IPLV)	2.0	1.7
RPM Full Load	3000	2.0
Gas Input (SCFII) <sup>2</sup> @6 - 28 in. 11,()	1750	3000 3500
Recoverable Heat at Full Load (BTU/H)3	850,000	
Acoustic Level (dBA) @ 20 ft.with Optional Enclosure	82	1,700,000 85
Electric Power Requirements	208 VAC Three phase,	208 VAC Three phase,
Chilled Water Flow (CDM)	35 Amps Service, 1 kW	50 Amps Service, 7 kW
Chilled Water Flow(GPM)	600	1200
Cooling Tower Requirements		
Condenser Flow Rate (GPM)	750	1500
Pressure Drop (ft. 11 <sub>2</sub> O)	11	11
Temperatures, without Exhaust Heat Exchangers ('F)'	85.0 - 95.0	85.0 - 95.0
Temperatures, with Exhaust Heat Exchangers (F)3	85.0 - 96.3	85.0 - 96.3
Exhaust		
Without Exhaust Heat Exchangers <sup>3</sup>	4 in. ANSI Flange, 300 SCFM, 26 in. of water max. back pressure, 1200°F max. temperature	(Same per engine
With Exhaust Heat Exchangers3	4 in. ANSI Flange, 300 SCFM, 16 in. of water max. back pressure, 300°F max. temperature	(Same per engine
Refrigerant	R-11(1,010 lbs.)	R-11 (1,770lbs)
TecoDrive <sup>IM</sup> Engines	One	Two
Rigging Weight (lbs.)	18,000	26,000
Dimensions 14'8"long x-4	'11" wide x 7'11" high 15' le	ong x 8' wide x 7'10" h

Note 1 | Per ARI 550 - 89 Method Note 2 | HHV 1020 BTU/SCF Note 3 60% of heat from engine jacket, exhaust manifold and oil cooler, 40% from engine exhaust heat exchanger



### EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY EMC PROJECT: #310

DATE: 22-Apr-92

ECO: 16, INVESTIGATE POST DEMAND

FILE: DEMAND.WK

PREPARED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK CHECKED BY:

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BLDG			EL NO.			N VOLTS	AMPS	TOTAL	TONS
		BWD	100_0			EACH	EACH	KW	EACH
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136	1	742AB		SPLIT		208		9	3.5
137	1	742AB		SPLIT		208		9	3.5
138	1	742AB		SPLIT		• 208		9	3.5
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PROGRAMMING	52	ā			-	\$150.00					\$150.00		
TRAINING, START-UP	-	rs				\$5,000.00					\$5,000.00		
RADIO SWITCHES	108	EA	1.5	162	\$21.17	\$3,429.54			\$100.00	\$10,800.00	\$14,229.54		
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SUBTOTAL						\$11,698.90				\$39,450.00	\$51,148.90		
OVERHEAD, BOND	15%					\$1,754.84				\$5,917.50	\$7,672.34		
PROFIT	10%					\$1,169.89				\$3,945.00	\$5,114.89		
COST SUB-TOTAL						\$14,623.63				\$49,312.50	\$63,936.13		
CONTINGENCY	15%					\$2,193.54				\$7,396.88	\$9,590.42		
TOTAL						\$16,817.17				\$56,709.38	\$73,526.54		
DA FORM 5418-R, APR 85													

PROJECT Ft McPherson & Ft Gillem ESOS Study LOCATION Ft McPherson & Ft Gillem  Cuantity  PEAK SHAVING GENEPATOR  TASK DESCRIPTION  SOO KW GENERATOR  H. EA  PAD  TANK  PAD  T EA  PAD	Ouentity iits Meas 1 EA 1 EA 1 EA 1 EA	2 2	LABOR   LABOR   H/c   Total   Hrs   66   66   66   66   66   66   66	DR Unit Price \$21.17 \$21.17 \$20.88	DACA 21 - 91 - C - 0097   X   CODE A   CODE   COD	B	CODEC		DATE APR 92 DRAWING NO. FSTIMATOR BMG		22-Apr-92 SHT OF	CB.
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TOTAL					\$8,650.33				\$121,040.0	41.00,130.3		-

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1   5   36   30   \$751.66	ENGINE DRIVEN CHILLER (460 TONS)	-	4	56	56	\$20.88	\$1,169.28			\$275,000.00	+	\$276,169.28		
1   EA   36   \$20.88   \$751.68	MISC. PIPE CONNECTIONS	-	ST							\$1,500.00		\$1,500.00		
25.090.16 25.090	REMOVE EXISTING CHILLER	-	+	36	36	\$20.88	\$751.68					\$751.68		
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TAL         \$1,920.96           EAD, BOND         \$288.14           BUB - TOTAL         \$1,920.96           \$1,920.96         \$288.14           \$1,920.96         \$1,920.96           \$1,920.96         \$1,920.96           \$1,920.96         \$1,920.96           \$1,920.96         \$1,920.96           \$1,920.96         \$1,920.96           \$1,920.96         \$1,920.96           \$1,920.96         \$2,401.20           \$1,920.96         \$2,401.20           \$1,920.96         \$2,501.36           \$1,920.96         \$2,501.36														
EAD, BOND         15%         \$288.14           BUB-TOTAL         \$192.10           IGENCY         \$380.18	SURTOTAL						\$1,920.96				\$276,500.00	-	9	
SUB-TOTAL     \$192.10       SUB-TOTAL     \$2,401.20       IGENCY     15%	OVERHEAD BOND	15%					\$288.14				\$41,475.00			
BUB-TOTAL         \$2,401.20           IGENCY         15%         \$360.18	PROFIT	10%					\$192.10				\$27,650.00			
IGENCY 15% \$360.18	COST SUB-TOTAL						\$2,401.20				\$345,625.00	$\rightarrow$		
6974138	CONTINGENCY	15%					\$360.18				\$51,843.75	\$52,203.93		
	TOTAL						\$2.761.38				\$397,468.75	\$400,230.13		

### E M C ENGINEERS, INC. Denver • Colorado Springs • Atlanta • Germany

Fort McPherson/Fort	Gillem ESOS Study
	OF
	DATE
	•
CHECKED BY	DATE
SCALE	

### 1) RADIO CONTROL FAMILY HOUSING AC UNITS

- -108 AC units
- -751 KW load
- -Estimate off for 7 minutes every 30 minutes, (7/30) = .23 load shed.
- -751 KW \* .23 = 175 KW
- -Cost \$73,527
- -Cost per KW, \$73,527/175 KW = \$420

### 2) THERMAL STORAGE, BLDG. 200

- -750 ton load, est 487 KW
- -With pumps, tower, etc. 673 KW
- -Cost \$1,044,893
- -Cost per KW, \$1,044,893/673 = \$155

### 3) GAS DRIVEN CHILLER

- -460 ton load, est 300 KW
- -Cost \$400,230
- -Cost per KW, \$400,230/300 = \$134

### 4) LIGHTING CONTROL

- -Control 310 watts of light (2, 4'x 2', 4 tube fluorescent)
- -1 wall switch, \$65.11
- -Cost per KW, \$65.11/.31 = \$210

### E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB Fort McPherson/Fo	ort Gillem ESOS Study
SHEET NOEMC #3105-000	) OF
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	DATE
SCALE	

### 5) PEAK SHAVING GENERATOR

- -500 KW generator
- -Est. cost \$130,190
- -Cost per KW, \$130,190/500 = \$260

### 6) HIGH EFFICIENCY MOTOR

- -5 hp high efficiency replacement
- -.81 KW savings
- -Cost \$488
- -Cost per KW, \$488/.81 = \$602

### 7) EXIT SIGN REPLACEMENT

- -Replace bulbs in 10 fixtures
- -.3 KW saved
- -\$380 construction cost
- -Cost per KW, 380/.3 = \$1267

# APPENDIX C-17 EVALUATE BOILER OPERATION

# E M C ENGINEERS, INC.

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: EVALUATE BOILER OPERATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**EMC PROJECT:** 

07/20/92 ILER.WK3 NNIS JONES #3105.000

	BOIL	DEN		
DATE	FILE:	PRPARED BY:	CHECKED BY:	

					SIMPLE	PAYBACK	(MRS)												
						SIR													
					CONST.	COST	(\$)												
				TOTAL	ANNOAL	SAVINGS	(\$)	12,086	800'6	9,008	800'6	800'6	800'6	800'6	800'6	800'6	800'6	800'6	102,166
	MBtu/ft2	KW/ft2		ANNUAL	NON-ENE	SAVINGS	(\$)												
SAVINGS FACTOR				11		SAVINGS	(\$)	0	0	0	0	0	0	0	0	0	0		0
	PWG	PW		ANNOAL	ENERGY	SAVINGS	(\$)	12,086	800'6	800'6	800'6	800'6	9,008	800'6	800'6	800'6	9,008	800'6	102,166
DISCOUNT	14.45 UPWG	10.59 UPW		TOTAL	ENERGY	SAVINGS	(MBtn)	2,588	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	21,878
	MBtu	. A	15 YRS	ANNOAL	NAT GAS	SAVINGS	(MBtn)	2,588	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	1,929	21,878
ENERGY COST	\$4.67 MBt	\$106.20 kW	15)	ANNUAL	ELECTRIC	SAVINGS	(KWH)	0	0	0	0	0	0	0	0	0	0	0	0
	) ()	AGE .		ANNUAL	DEMAND	SAVINGS	SS SS	0	0	0	0	0	0	0	0	0	0	0	0
	NCREMENTAL GAS COST	ELECTRIC DEMAND CHARGE	LIFE	EXISTING	Š	VALUE	(BTUXHR/F)	82,888	61,791	61,791	61,791	61,791	61,791	61,791	61,791	61,791	61,791	61,791	700,798
	INCREMENT	ELECTRIC D	ECONOMIC LIFE		BUILDING	NUMBER		202	505	206	202	208	209	510	511	512	513	514	TOTAL

# APPENDIX C-18 EXIT SIGN RETROFIT

FIS	SCAL YEAR	1992 DISC	T ANALYSIS SU INVESTMENT P FT. GILLEM A21-91-C-0097 RETE PORTION ECONOMIC LI	NAME:	ECO-18	EXIT SIGN F	RETRO	TOCKATI
	B. SIOH C. DESIGN D. SALVACE. TOTAL	RUCTION COST N COST GE VALUE COS INVESTMENT	T (1A + 1B + 1C	: - 11	o)		•	20634. 1135. 1238. 0. 23007.
2.	ENERGY SAV	VINGS (+) / DATE ANNUAL	COST (-) SAVINGS, UNI	T CO	ST & DISC	COUNTED SAV	NGS	
	FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANN SAV	JAL \$ INGS(3)	DISCOUNT FACTOR(4)	DIS SAV	COUNTED 'INGS (5)
	A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ 7.47 \$ .00 \$ .00 \$ 4.67 \$ .00	487. 0. 0. 0. 0.	\$ \$ \$ \$	3639. 0. 0. 0.	15.61 21.66 26.51 23.77 16.06		56803. 0. 0. 0.
	F. TOTAL		487.	\$	3639.		\$	56803.
3.		Y SAVINGS(+)						
	A. ANNUAL	RECURRING (	+/-) OR (TABLE A) VING/COST (3A			14 52	\$	32.
	(1) D: (2) D:	ISCOUNT FACT ISCOUNTED SA	OR (TABLE A) VING/COST (3A	x 3	A1)	14.55	\$	465.
	C. TOTAL	NON ENERGY D	ISCOUNTED SAV	INGS	(+)/COST	(-) (3A2+3Bd	1)\$	465.
	(1) 2	5% MAX NON E A IF 3D1 IS B IF 3D1 IS C IF 3D1B IS	QUALIFICATION OF THE PROJECT OF THE	F5 X TO SIR TE	.33) ITEM 4 = (2F5+3I M 4	)1)/ 1B/	<b>1</b> 5.	
4.	FIRST YEAR	R DOLLAR SAV	INGS 2F3+3A+(	3B1D	/(YRS ECC	ONOMIC LIFE	))\$	3671.
			SAVINGS (2F5+					57268.
6.	DISCOUNTED	D SAVINGS RA PROJECT DOES	TIO NOT QUALIFY)	(S	IR)=(5 /	1E)= 2.4	49	
7.	SIMPLE PA	YBACK PERIOD	(ESTIMATED)	S	PB=1E/4	6.3	27	

### REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18 BUILDING 41

### Given:

# of Exit Signs = 4 signs - from field survey

Existing Bulb Wattage = 40 Watts - from field survey

Improved Bulb Wattage = 10 Watts - from manufacturer's data

Gas Cost = \$4.67 / MBtu - from utility rate analysis

Electric Cost = \$0.0255 / kWh - from utility rate analysis

Demand Cost = \$8.85 / kW - from utility rate analysis

### Existing Energy Usage:

 $(4 \text{ signs})^*(40 \text{ Watts / sign}) = 160 \text{ Watts}$  $(0.16 \text{ kW})^*(8,760 \text{ hrs / yr}) = 1,402 \text{ kWh}$ 

### Improved Energy Usage:

 $(4 \text{ signs})^*(10 \text{ Watts / sign}) = 40 \text{ Watts}$  $(0.04 \text{ kW})^*(8,760 \text{ hrs / yr}) = 350 \text{ kWh}$ 

### Peak Demand Savings:

(0.16 - 0.04 kW) = 0.12 kW

### **Annual Energy Savings:**

- Electric: (1,402 - 350 kWh) = 1,052 kW - Gas: = 0 MBtu

### **Annual Energy Cost Savings:**

 $(0 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (1,052 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.12 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$39 / \text{ yr}$ 

### Annual Increased recuring cost

(\$7.95) - (2 \* \$2.25) \* (8,769 yr / 10,000 hr) = \$3.02 / yr / fixture 4 fixtures = 4 \* \$3.02 = \$12.08 / yr

### **Estimated Construction Cost:**

\$38.00 / sign - from engineer's cost estimate

(\$38.00 / sign)\*(4 sign) = \$152

\$152 + (\$152 \* .055 SIOH) + (\$152 \* .06 DESIGN) = \$169

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM ECO: REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

#3105.000 07/20/92 **EMC PROJECT:** DATE: FILE:

CAMERAN DIBAI **GEXITLIT.WK3** PRPARED BY:

CHECKED BY:

	ENERGY	DISCOUNT	
	COST	FACTOR	
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG	
	\$0.0256 kWh	15.61 UPWE	
	\$102.66 kW	14.53 UPW	
ECONOMIC LIFE	25 YRS		
<b>ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR</b>			

	SIMPLE	PAYBACK	(YRS)	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
		SIR		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	25
	CONST.	COST	(\$)	\$2,966	\$381	\$2,034	\$1,695	\$2,034	\$847	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$1,271	\$339	£03 007
TOTAL	ANNOAL	SAVING	€	\$475	\$61	\$326	\$271	\$326	\$136	\$204	\$204	\$204	\$204	\$204	\$204	\$204	\$204	\$204	\$204	\$54	202 69
ANNUAL	ENERGY DEMAND NON-ENER ANNUA	SAVINGS	(\$)	(\$211.40)	(\$27.18)	(\$144.96)	(\$120.80)	(\$144.96)	(\$60.40)	(\$30.60)	(290.60)	(\$30.60)	(\$30.60)	(\$30.60)	(\$90.60)	(\$90.60)	(\$30.60)	(\$30.60)	(\$90.60	(\$24.16)	(20 0ca )
ANNOAL	DEMAND	SAVINGS	9	\$216	\$28	\$148	\$123	\$148	<b>29\$</b>	\$92	\$92	892	\$92	\$92	\$92	\$92	\$92	\$92	\$92	\$25	C. C. 10
ANNUAL ANNUAL	ENERGY	SAVINGS	(\$)	\$471	\$61	\$323	\$269	\$323	\$135	\$202	\$202	\$205	\$202	\$202	\$205	\$202	\$205	\$202	\$202	\$54	630 60
TOTAL	ENERGY	SAVINGS	(MBtu)	83	80	43	96	43	18	27	27	27	27	27	27	27	27	27	27	2	107
ANNUAL	NAT GAS	SAVINGS	(MBtu)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	•
ANNUAL	ELECTRIC	SAVINGS	(KWH)	18,396	2,365	12,614	10,512	12,614	5,256	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	2,102	COL 27.
ANNUAL	DEMAND	SAVINGS	(K	2.1	0.27	1.44	1.2	4.	9.0	6.0	0.0	6.0	6.0	0.9	6.0	6.0	0.9	0.9	0.9	0.24	
	NUMBER	占	FIXTURES	70	6	48	9	48		8	8	8	8	8	8	8	8	30	99	8	
			BLDG	G101	103	207	213	G400	G401	505	206	205	508	509	510	511	512	.513	514	935	7 W 1000 TOT 1000

PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft Gillem Couantity TASK DESCRIPTION Countity No. Of Unit TASK DESCRIPTION Units Meas EXIT SIGN RETROFIT KIT 1 EA	antity f Unit Meas	호의	LABOR II Hrs 1 0.5	DR Unit Price 5 \$21.17	DACA 21 – 91 – C – 0097  X CODE A CODE OTHER Cost Price \$10.59	DACA 21 – 91 – C – 0097  X	Code C	DA DR ES MATERIAL Unit Price \$15.00	DATE APR 92 DRAWING NO. ESTIMATOR FMG TO		22-Apr-92 SHT OF	GE.
SOS Study  Quan  Units  Units				<u> </u>	Cost \$10.59	CODE B  EQUPMI  Price	CODE C	Ш о	DRAWING NO ESTIMATOR F		SHT OF	ਜੁ
Ouan No. Or Units				— K	Cost \$10.59	5 &	Cost	Ш 0	ESTIMATOR F			Б
No. Of Units				15 15 1	\$10.59	5 &	L C C St	<u> </u>	ΙΦΙ		CHECKED BY CEL	
No. Of Linits					Cost \$10.59	j.F	COst	Unit Price \$15.00	_	¥	SHIPPING	g
Units	<del></del>		I		\$10.59		S O	Price \$15.00	!		Unit	Total
	<del>-   -   -   -   -   -   -   -   -   -  </del>				\$10.59			\$15.00	Cost		\$	₹
									\$15.00	\$25.59		
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	-	+			61059				\$15.00	\$25.59	6	
SUBTOTAL	à	+			5.5				\$2.25	\$3.84	-	
EAU, BOND	R 3	-			25				\$1.50	\$2.56		
PROFIL	2	-			61203				\$18.75	\$31.98	<b>m</b>	
DTAL.	  -   :	+			913.62				\$2.81	\$4.80	0	
CONTINGENCY	8				B. 19				\$21.56	\$36.78		
TOTAL		-	-		22.014							

### APPENDIX C-19 LIGHTING UPGRADES

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062 INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT FISCAL YEAR 1992 ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC 1. INVESTMENT 2135242. A. CONSTRUCTION COST \$ 117439. B. SIOH 128115. C. DESIGN COST ٥. D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1C - 1D) 2380796. 2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS DISCOUNT DISCOUNTED ANNUAL \$ UNIT COST SAVINGS SAVINGS(3) FACTOR(4) SAVINGS(5) MBTU/YR(2) FUEL \$/MBTU(1) 1182934. 15.61 75781. 7.47 10143. A. ELECT \$ 21.66 0. .00 ٥. B. DIST \$ 0. ٥. ٥. 26.51 C. RESID \$ .00 ٥. \$ 0. 23.77 0. D. NAT G \$ 4.67 0. 0. 16.06 0. ٥. E. COAL \$ .00 1182934. 75781. \$ F. TOTAL 10143. 3. NON ENERGY SAVINGS(+) / COST(-) 130378. A. ANNUAL RECURRING (+/-) 14.53 (1) DISCOUNT FACTOR (TABLE A) 1894392. (2) DISCOUNTED SAVING/COST (3A X 3A1) C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)\$ 1894392. D. PROJECT NON ENERGY QUALIFICATION TEST 390368. (1) 25% MAX NON ENERGY CALC (2F5 X .33) A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)
C IF 3D1B IS = > 1 GO TO ITEM 4 D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY 4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 3077327. 5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) (SIR) = (5 / 1E) =6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALIFY) \*\*\*\* Project does not qualify for ECIP funding; 4,5,6 for information only. SPB=1E/4 11.55 7. SIMPLE PAYBACK PERIOD (ESTIMATED)

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 19 - PNL Lights

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

PREPARED BY: R. GERRANS

CHECKED BY:

FILE: ECO-19.WK3

EMC PROJECT: #3105.000

15-Jul-92

DATE:

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / KW	14.53 UPW

Economic Life: 15 yrs

							ANNUAL				
	PEAK	ANNUAL ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNOAL	-NON	TOTAL			
BLDG #	DEMAND	BLDG # DEMAND ELECTRIC	GAS	ENERGY	ENERGY	DEMAND	ENERGY	ANNUAL	CONST	SIR	SIMPLE
	SAVINGS	SAVINGS SAVINGS SAVINGS	SAVINGS	SAVINGS	SAVINGS		SAVINGS	SAVINGS	COST		PAYBACK
	(kW)	(kWh/yr) (MBtu/yr) (MBtu/yr)	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	(\$/yr)		<b>(\$</b> )		(yrs)
Office	483	1,130,220	0	3,854			<b>9</b>	\$78,405	\$854,105	4.1	10.9
Warehouse		787 1,841,580	0	6,280	\$46,960		\$0	\$127,754	\$127,754 \$1,526,690	1.2	12.0
TOTAL	1,270	1,270 2,971,800	0	10,134		130,378	0	206,159	206,159 2,380,795	1.3	11.5

# M C ENGINEERS, INC. Ш

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: 19 - PNL Lights LOCATION: FORT GILLEM

CLIENT CONTRACT NO: DACA21-9-C-0097

PREPARED BY: R. GERRANS CHECKED BY:

FILE: ECO-19.WK3 DATE: 2-APR-92

EMC PROJECT: #3105.000

CLIENT PROJECT ENG: TERRY SEABROOK

Operation:

2340 hrs / yr

Bldg. Type	Exist Demand (kW)	Imprvd Demand (kW)	Cooling Demand Savings (kW)	Demand Savings (kW)	Electric Usage Savings (kWh/yr)	Installation Cost (\$)
Warehouse	1,705	918	0	787	1,841,580	\$1,369,229
Office	1,201	718	0	483	1,130,220	\$766,014

TRI-SERVICE P	1ILITARY	CONSTRUCTION	PROGRAM	(MCP)	TNDEY
---------------	----------	--------------	---------	-------	-------

5 1996
9
2
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9
5

### Example: (For 10 Month Construction Period)

Submittal Date Bid Opening Date Contract Award Date Midpoint of Construction	- 1 Sept 90 - 1 Apr 91 - 1 May 91 - 1 Oct 91	1720 13 Months
--	---	----------------

Cost Growth Factor = 1793 / 1720 = 1.0424 Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

### \* Historical

Cost Growth Factor = 1819/1676 = 1.0853 Use [1.09]

### FEASIBILITY STUDY FOR LIGHTING SHARED ENERGY SAVINGS PROJECT FORT McPHERSON AND FORT GILLEM, GEORGIA

U.S. Army Corps of Engineers Huntsville Division Contract DACA87-89-D-0007 Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a  $2 \times 4$  or a  $2 \times 2$  louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at \$1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at \$2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

### 3.7 CAPITAL COST ESTIMATE

### 3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of \$1,255,900 (in 12/89 dollars). This does not include \$273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is \$253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at \$25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

### 3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be \$1,294,120 for both Fort Gillem (\$702,765) and Fort McPherson (\$591,355 including \$244,483 for CCF), including the Comand and Control Facility. Unlike the warehouses, no supply rewiring is required.

### 3.8 MAINTENANCE COST ESTIMATE

### 3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is \$53,611.

### SECTION 4

### ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	Fort Gillem	Fort McPherson	<u>Total</u>
Existing load (kW) Future loads (kW) Savings (kW) Percent savings	1,201 <u>718</u> 483	1,217 669 548	2,418 1,387 1,031 43%

In the CCF alone, the load will be reduced from 507~kW to 255~kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	Incremental <u>Usage (kWh)</u>	Rate (\$/kWh)
<pre>&lt;300 hr/mo * Billing Demand: (up to maximum of 1,961,500 kWh)</pre>	50,000 150,000 800,000 961,400	0.05710 0.05590 0.04150 0.03950
>300 hr/mo * Billing Demand:	Balance of kWh	0.01110

In addition, a fuel charge of \$0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from \$0.066/kWh to \$0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

### OFFICE (ALL) POWER COST

	onthly Energy ich Includes		Existing	System	_Modified	System
Hr/Mo	Incr. kWh	Rate		534 kWh/Mo Cost		314 kWh/Mo
	- RWII	nace	KWII	COSC	KWII	Cost
<300	50,000	\$0.0571	50,000	\$ 2,855	50,000	\$ 2,855
	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	0	0	0	. 0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566	270,314	\$ 4,337
				\$30,074	·	\$18,495
		Avg	. Rate	\$0.064/kWh		\$0.068/kWh

### COMMAND AND CONTROL FACILITY POWER COST

Exi:	sting Syst	tem			Modified Syst	em
	<u>kWh</u>	@ Avg. rate from above	Cost	<u>kWh</u>	@ Avg. rate from above	Cost
Lighting Costs:	98,865	\$0.064/kWh	\$6,327	49,725	\$0.068/kWh	\$3,381
Differential Air Cond. Costs:	Base		<u>base</u> \$6,327	-15,379	0.068	-1,046 \$2,335

# APPENDIX C-20 COMPUTER SIMULATION SUMMARIES

# E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

FILE: G101ECO.WK3 PREPARED BY: R. GERRANS CHECKED BY: EMC PROJECT: #3105.000 DATE: 13-APR-92

Bida: G101	Area: 120,182 π 2	7 1 2 N Z									1
0	Heating	Heating	Cooling	Fan	Pump	Lighting	Recept.	Total	Peak	l otal Gas	Fnergy
Ğ	Gas	Lise	Use	Use	Use	Use	Use	Use	Demand	Use	Use
Description	(kBtu/vr)	(kWh/vr)	(kWh/vr)	(kWh/vr)	(kWh/yr)	(kWh/yr)	(kWh/yr)	(kWh/yr)	(kW)	(MBtu/yr)	(Mpt
Baseline	523,833	8,551	299,666	416,645	236,958	729,764	439,234	2,130,817	929	524	7,794
IIOM F#COL	305 157	6 736	283 434	416 645	236.958	729.764	439,234	2,112,770	651	305	7,514
Savings/(Loss)				0	0		0		19	219	280
C * C C L	404 179	6 910	297 925	416 645	236.958	729.764	439.234	2,127,435	661	401	7,660
Savings/(Loss)			1,741		0			3,382	<b>o</b>	123	- - - - - -
6#CCL		8.356	299 243	416 645	236.958	729.764	439.234	2,130,199	899	505	7,773
Savings/(Loss)									2	61	2
9#003	523 833	8.551	297.878	416,645	236,958	729,764	439,234	2,129,030	029	524	7,78
Savings/(Loss)							0	1,788	0	0	9
£#00L	200 370	2 538	277 243	416.645	140.860	729.764	439,234	2,006,253	029	290	7,136
Savings/(Loss)								_		233	658
ECO#10	221 515		192.948	349,638	132.000	729,764	439,234	1,845,631	613		
Savings/(Loss)		6,504						285,187	75	305	1,275
200	E03 833	8 551	312 788	416 645	236 958	729.764	439,234	2,143,939	544	524	1,839
Savings/(Loss)									126	0	(45)
ECO#15	565.330	9.020	281.067	416,645	236,958	613,004	439,234	<b>—</b>	029		7
Savinos/(Loss)							0	134,889	0	<b>4</b>	419

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT McPHERSON ECO: Computer Simulation Summary

07/20/92 G207ECO DENNIS JONES

PREPARED BY: CHECKED BY:

#3105.000

**EMC PROJECT:** 

DATE: FILE:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

Bldg: G207	Area: 149,300 ft ~ 2	300 ft ^ 2									
	Heating	Heating	Cooling	Fan	Pump	Lighting	Receat.	Total	Peak	Total	Total
	Gas	Electric	Electric	Electric	Electric	Electric	Electric	Electric	Electric	Gas	Energy
Ban	Use	Use	Use	es)	Use (1)	- BS -	Use	<b>8</b>	Demand	nse T	OSO.
Description	(kBtu/yr)	(KWh/yr)	(kWh/yr)	(kWh/yr)	(kWh/yr)	(KWh/yr)	(kWh/yr)	(kWh/yr)	<u>(</u> €	(MBtu/yr)	(MBtu/yr)
Baseline	6,317,652	8,200	0	155,220	0	295,749	0	459,169	0	6,318	7,885
Wall Insulation	6,241,559	8,200	0	152,300	0	295,749	0	456,249	0	6.242	7.799
Savings (Loss)	76,093	0	0	2,920	0	0	0	2,920	0	76	98
Roof Insulation	2,208,442	6,937	0	47,943	0	295,749	0	350,629	0	2.208	3.405
Savings (Loss) 4,109,210	4,109,210	1,263	0	107,277	0	0	0	108,540	0	4,109	4,480
Insulated Glass	6,287,502	8,200	0	154,555	0	295,749	0	458,504	0	6.288	7.852
Savings (Loss)	30,150	0	0	665	0	0	0	999	0	30	32
Weatherstripping and Caulk	6,310,442	8,200	0	155,042	0	295,749	0	458,991	0	6,310	7.877
Savings (Loss)	7,210	0	0	178	0	0	0	178	0	7	80
Destratification Fans	5,806,827	7,984	0	219,168	0	295,749	0	522,901	0	5.807	7.591
Savings (Loss)	510,825	216	0	(63,948)	0	0	0	(63,732)	0	511	293
Radiant Heaters	6,010,785	7,794	0	0	0	295,749	0	303,543	0	6,011	7,047
Savings (Loss)	306,867	406	. 0	155,220	0	Ö	0	155,626	0	307	838
Loading Dock Seals	5,981,313	8,085	0	146,557	0	295,749	0	450,391	0	5,981	7.518
Savings (Loss)	336,339	115	0	£99'8	0	6	0	8,778	0	336	366
Lighting Controls	6,532,542	8,239	0	149,773	0	159,705	0	317,717	0	6,533	7,617
Savings (Loss)	(214,890)	(39)	0	2442	0	136,044	0	141,452	0	(215)	268
Continuous Boiler Operation	8,905,955	11,988	0	232,830	0	295,749	0	540,567	0	8,906	10,751
Savings (Loss) (2,588,303)	(2,588,303)	(3,788)	O	(019'22)	0	0	0	(81,398)	0	(2.588)	(2.866)

# APPENDIX D

# ECO PROJECT BACKUP CALCULATIONS

D-1 MCA PROJECT 1
D-2 MCA PROJECT 2
D-3 LOW-COST/NO-COST PROJECT 1

D-4 NAF

# APPENDIX D-1 MCA PROJECT 1

ECO-1, ADD DUCT INSULATION

ECO-1, ADD ROOF INSULATION

ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

ECO-7, CONTROL HOT WATER CIRCULATION PUMPS

ECO-11, REPLACE STREET LIGHTS

ECO-12, REVISE OR REPAIR HVAC CONTROLS

ECO-14, RADIANT HEATERS

ECO-15, SEPARATE SWITCHES TO CONTROL LIGHTING

ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS

PR FI	STALLATION OJECT NO. SCAL YEAR	<pre>  &amp; LOCATION: &amp; TITLE: DAG 1992 DISG</pre>	NINVESTMENT FI. GILLEM CA21-91-C-009 CRETE PORTION CECONOMIC L	RI 7 I NAMI	EGION NOS ENERGY SA' E: MCA PRO	. 4 CENSUS: VINGS OPPORT OJECT 1	E TINU	
1.	B. SIOH C. DESIG	RUCTION COST		c – :	lD)		\$	666557. 36661. 39994. 0. 743212.
2.	ENERGY SA ANALYSIS	VINGS (+) / DATE ANNUAL	COST (-) L SAVINGS, UN	IT CO	OST & DISC	COUNTED SAVI	NGS	
	FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANI SAV	NUAL \$ /INGS(3)	DISCOUNT FACTOR (4)	DIS SAV	COUNTED 'INGS (5)
	A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ 7.47 \$ .00 \$ .00 \$ 4.67 \$ .00	3363. 0. 0. 6919. 0.	\$ \$ \$ \$	25125. 0. 0. 32312.	11.11 14.26 16.89 14.45 11.21		279142. 0. 0. 466905.
	F. TOTAL	•	10282.	\$	57437.		\$	746046.
3.		Y SAVINGS(+)						
	A. ANNUAL (1) D (2) D	RECURRING ( ISCOUNT FACT ISCOUNTED SE	(+/-) TOR (TABLE A) AVING/COST (32	A X 3	BA1)	10.59	\$ \$	8410. 89062.
	C. TOTAL	NON ENERGY	SISCOUNTED SAY	VINGS	(+)/COST	(-) (3A2+3Bd4	<b>()</b> \$	89062.
	(1) 2	5% MAX NON E A IF 3D1 IS B IF 3D1 IS C IF 3D1B IS	QUALIFICATION CALC (SERVICE CALC CALC CALC CALC CALC CALC CALC CA	2F5 } O TO SIR O ITE	( .33) ITEM 4 = (2F5+3I EM 4	D1)/1E)		
4.	FIRST YEA	R DOLLAR SAV	/INGS 2F3+3A+	(3811	O/(YRS EC	ONOMIC LIFE)	)\$	65847.
5.	TOTAL NET	DISCOUNTED	SAVINGS (2F5	+3C)			\$	835108.
6.	DISCOUNTE (IF < 1	D SAVINGS RAPPOJECT DOES	ATIO S NOT QUALIFY	( £ )	SIR)=(5 /	1E)= 1.1	.2	
7.	SIMPLE PA	YBACK PERIOR	(ESTIMATED)	S	SPB=1E/4	11.2	9	

STUDY: GPJ1

LIFE CYCLE COST ANALYSIS SUMMARY

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

EMC PROJECT: #3105.000

02-Sep-92

DATE:

PREPARED BY: CMD FILE: FNLECO.WK3

CHECKED BY: CEL

**MCA PROJECT 1** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

11.11 UPWE 10.59 UPW 14.45 UPWG **FACTOR** DISCOUNT 23.77 UPWG 15.61 UPWE 14.53 UPW **FACTOR** DISCOUNT \$4.67 / MBtu \$0.0255 / kWh \$8.85 / kW COST ENERGY Demand Savings PROJECT ECONOMIC LIFE 15 YEARS Electric Savings Gas Savings

ECO #         ECONOMIC DEMAND ELECTRIC GAS LIFE         ANNUAL GAS LIFE         ANNUAL GAS CAVINGS SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS SAVINGS CO - 1		INNUAL	_								
O# ECONOMIC LIFE (YRS) D 25 R 25 15		LECTRIC	ANNOAL	TOTAL	ANNOAL	ANNUAL	NON	TOTAL			
(YRS) (YRS) D 25 R 25 15 15	——	COMME	GAS	ENERGY	ENERGY	DEMAND	ENERGY	ANNUAL	CONST	SIR	SIMPLE
CYRS)         (kW)         (kWh/yr)         (MBtu           D         25         0         4,596         4           R         25         0         108,540         4           15         11         71,225         7         7           15         0         124,564         7         7           1         25         0         4,928         7	(kW)	SAVINGO		SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST		PAYBACK
B 25 0 1 1 15 0 1 1 15 0 1 1 1 25 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25 0	kWh/yr)	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	(\$/Ar)	(\$/vr)	9		(VIS)
15 0 1 15 11 15 11 15 11 15 11 15 11 15 11 15 11 15 11 15 11 11		4,596	38	54	\$295	80	80	\$295	\$2.040	3.0	69
15 11 15 0 1 1 25 0		108,540	4,109	4,479	\$21,957	\$0	\$0	\$21,957	\$419,503	1.2	19.1
1 25 0 12	15 11	71,225	0	243	\$1,816	\$1,102		\$2.918	\$37,154	1.2	12.7
25 0		124,564	233	658	\$4,271	\$0	80	\$4.271	\$9,868	46	2.3
	25 0	4,928	0	17			\$174	\$300	\$2,682	1.7	6
ECO-12 15 57 285,187		285,187	302	1,274	\$8,683	\$5,852	\$127	\$14.661	\$57.547	2.9	6.6
ECO-14-HEAT 15 0 263,425 2	2,00	263,425	2,007	2,906	\$16,090	\$0	\$0	\$16,090	\$166,198	1.3	10.3
ECO-15 25 11 47,766	25 11	47,766	(18)	145	\$1,136	\$1,141	\$0	\$2,277	\$30,072	-	13.2
ECO-18 25 7 63,860	25 7	63,860	0	218	\$1,635	\$748	(\$734)	\$1,649	\$10,296	2.5	6.2
TOTAL 86 974,092 6	98	974,092	6,671	9,994	\$56,008	\$8,843	(\$433)	\$64,418	\$735,360	+.	11.4

ECO-1, ROOF INSULATION

LIFI ENERGY CO INSTALLATION & PROJECT NO. & FISCAL YEAR 19 ANALYSIS DATE:	992 DISC	RETE PORTION	NAME: ECO-1	ROOF INSULAT	ION	
B. SIOH C. DESIGN	COST	··	C - 1D)		\$ \$ -\$	3173436. 174539. 190407. 0. 3538382.
2. ENERGY SAV	INGS (+) / DATE ANNUAL	COST (-) SAVINGS, UNI	T COST & DIS	COUNTED SAVI	NGS	
			ANNUAL \$ SAVINGS(3)			
A. ELECT S B. DIST S C. RESID S D. NAT G S E. COAL	7.47 .00 .00 4.67	3041. 0. 0. 34889. 0.	\$ 22723. \$ 0. \$ 0. \$ 162932. \$ 0.	15.61 21.66 26.51 23.77 16.06		354701. 0. 0. 3872885.
F. TOTAL		37930.	\$ 185654.		\$	4227586.
3. NON ENERGY						
A. ANNUAL I (1) DIS (2) DIS	RECURRING ( SCOUNT FACT SCOUNTED SA	+/-) OR (TABLE A) VING/COST (3 <i>F</i>	A X 3A1)	14.53	\$ \$	0.
			/INGS(+)/COST			
(1) 25° A B C	MAX NON E IF 3D1 IS IF 3D1 IS IF 3D1B IS	= OR > 3C GO < 3C CALC = > 1 GO TO	2F5 X .33) D TO ITEM 4 SIR = (2F5+3)	D1)/1E)		
4. FIRST YEAR	DOLLAR SAV	INGS 2F3+3A+(	(3B1D/(YRS EC	ONOMIC LIFE)	)\$	185654.
5. TOTAL NET I	DISCOUNTED	SAVINGS (2F5	+3C)		\$	4227586.
6. DISCOUNTED (IF < 1 P)	SAVINGS RA ROJECT DOES	TIO NOT QUALIFY)	(SIR)=(5 /	1E)= 1.1	9	
7. SIMPLE PAY	BACK PERIOD	(ESTIMATED)	SPB=1E/4	19.0	6	

# ROOF INSULATION SAMPLE CALCULATION, ECO #1 BUILDING 111

## Given:

Roof Area  $= 2,150 \text{ ft}^2$ - from bldg plans Existing Roof U-value  $= 0.202 \text{ Btuh / hr }^{\circ}\text{F ft}^{2}$ - from survey notes Improved Roof U-value = 0.042 Btuh / hr °F ft<sup>2</sup> - from survey notes Gas Savings Factor = 0.0083 MBtu / UA- from Bldg 100 simulation Electric Savings Factor = 1.8 kWh / UA- from Bldg 100 simulation Demand Savings Factor = 0.0 kW- from Bldg 100 simulation Gas Cost = \$4.67 / MBtu - from utility rate analysis Electric Cost - from utility rate analysis = \$0.0255 / kWhDemand Cost - from utility rate analysis = \$8.85 / kW

# **Existing Roof UA:**

 $(2,150 \text{ ft}^2)^*(0.202 \text{ Btuh / hr }^\circ\text{F ft}^2) = 434.3 \text{ Btuh / hr }^\circ\text{F}$ 

# Improved Roof UA:

 $(2,150 \text{ ft}^2)^*(0.042 \text{ Btuh / hr }^\circ\text{F ft}^2) = 90.3 \text{ Btuh / hr }^\circ\text{F}$ 

### Delta UA:

 $434.3 - 90.3 = 344.0 \text{ Btuh / hr }^{\circ}\text{F}$ 

## Peak Demand Savings:

 $(344.0 \text{ UA})^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

# **Annual Energy Savings:**

- Gas:  $(344.0 \text{ UA})^*(0.0083 \text{ MBtu} / \text{UA}) = 2.9 \text{ MBtu}$ - Electric:  $(344.0 \text{ UA})^*(1.8 \text{ kWh} / \text{UA}) = 619 \text{ kWh}$ 

# **Annual Cost Savings:**

 $(2.9 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (619 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.0 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$29 / \text{yr}$ 

### **Estimated Construction Cost:**

\$0.68 / ft<sup>2</sup> of wall - from engineer's cost estimate

 $(\$0.68 / \text{ft}^2)^*(2,150 \text{ ft}^2) = \$1,462$ 

\$1,462 + (\$1,462 \* .055 SIOH) + (\$1,462 \* .06 DESIGN) = \$1,630

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 1 - Roof Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 02-Sep-92 FILE: ECO-1R.WK3 PREPARED BY: R. GERRANS

CHECKED BY:

	ENEBGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / KW	14.53 UPW
> -		

Economic Life: 25 yrs

		SIMPLE	PAYBACK	(yrs)	19	19
		SIR			1.2	1.2
	!	CONST	COST	(\$)	\$419,503	\$419,503
	TOTAL	ANNOAL	SAVINGS	(\$/yr)	\$21,957	\$21,957
ANNOAL	       	ENERGY	SAVINGS	(\$/yr)	\$0	\$0
	ANNOAL	DEMAND	SAVINGS	(\$/yr)	0\$	0\$
	ANNOAL	ENERGY	uı	(\$/yr)	\$21,957	\$21,957
	TAL	ENERGY	SAVINGS	(MBtu/yr)	4,479	\$4,479
	ANNOAL	GAS	SAVINGS	(MBtu/yr)	4,109	\$4,109
	PEAK ANNUAL ANNUAL	ELECTRIC	SAVINGS SAVINGS SAVINGS	(kWh/yr)	0 108,540 4,109 4,479	\$0 \$108,540
	PEAK	BLDG # DEMAND ELECTRIC	SAVINGS	(kW)	0	0\$
		BLDG #			207	TOTAL

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 1 - Roof Insulation

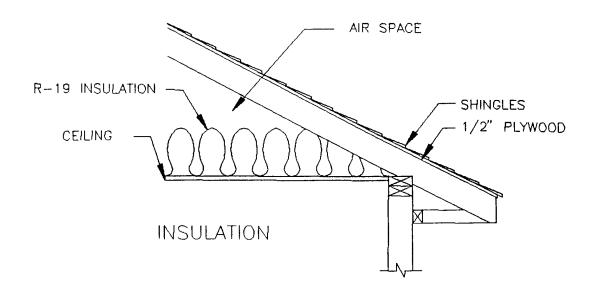
CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

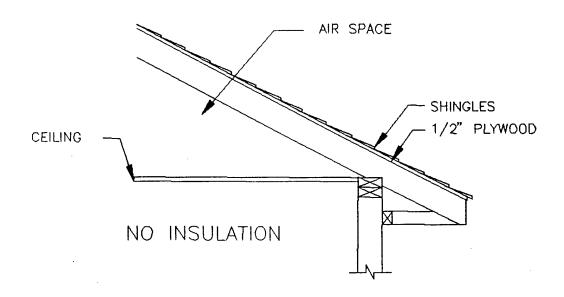
EMC PROJECT: #3105.000 DATE: 15-APR-92 FILE: ECO-1R.WK3 PREPARED BY: R. GERRANS CHECKED BY:

-	_													
BLDG # ROOF	ROOF	EXIST	EXIST	UVBQVI	11/00//0					PEAK	ANNUAL	ANNOA	LINI	
	AREA	ROOF	ROOF	ROOF	ROOF	DE! TA	DEMAND	ELECTRIC		DEMAND	ELECTRIC	GAS	CONST	CONST
100	(ft2)	U-VALUE	Ϋ́	U-VALUE	5	בררו וא	(KW// IA)	SAVINGS		SAVINGS		SAVINGS	COST	COST
797	149,300	0.518	77,337	0.048		ľ	(VO /au)	(NAVII/UA)	MPI	(KW/yr)	(kWh/yr)	(MBtu/yr)	( <b>\$</b> /ft²)	9
၁၅၁	111,000	0.518	57,498	0.048				C.		0	108,540	4,109	\$2.52	\$376 236
909	111,000	0.518	!	0.048		52 170		Ç.		0	78,255	3,078	1	\$279 720
207	111,000	0.518	57 498	0.048		50 170		C.	0.059	0	78,255	3.078	\$2.52	\$279 720
	111,000	0.518	1	0.048		52,170		3.	0.059	0	78.255	3,078	- 1	8279 720
	111,000	0.518		0.048		52,170	0	1.5	0.059	0	78,255	3,078		\$279 720
	111,000	0.518	<u>.                                    </u>	0.048		, , ,		1.5	0.059	0	78,255	3,078	1	\$279 720
-	111,000	0.518	L.	0.048				5.	0.059	0	78,255	3,078	1	\$279 720
	111,000	0.518	•	0.048	5,328	52 170		٠ د	0.059	ō	78,255	3,078	1	\$279,720
- -	111.000	0.518	57,498	0.048	5.328	52 170			0.059	ō	78,255	3,078	\$2.52	\$279,720
514	111,000	0.518	57,498	0.048	5 328	52 170		٠	0.059	Ö	78,255	3,078	1	\$279.720
						26.170		Ċ.	0.059	0	78,255	3,078	Ι.	\$279,720

		)			-			j			1		)
		)				DACA 21-	DACA 21-91-C-0097			DATE APR 92	2	Ā	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	Study					X CODE A	CODEB	CODEC		DRAWING NO.	Ci.	SHT	
LOCATION Ft. McPherson & Ft Gillem					_J	± 5				ESTIMATOR PMG	₽MG	CHECKED BY	
		1		ABOR -			EGU	EQUIPMENT	MATERIAL	FIAL.	TOTAL	SHIPPING	g
ECO 1 - Roof, Warehouse	No. Of	Chit	MH.	Total			Unit	1	Cnit	1		Chit	Total
TASK DESCRIPTION	Units	8	Chit	I S	Price	Cost	Price	Cost	1100	20 Ag	8		
ISOCYANURATE, FOLL FACED, 3° THICK	_	1   SF	0.011	0.011	\$18.53	\$0.20		_	7		3 6		
AERIAL LIFT, TELESCOPING BOOM	0.011 HR	Ŧ					\$5.60	\$0.06			90.00		
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		_									1		
SUBTOTAL											97.70		
OVERHEAD, BOND	15%							_			3 3		
PROFIT	10%								 		5 5		
COST SUB-TOTAL											20.33		
CONTINGENCY	15%										82.52		
SUBTOTAL		_											
S&A	_												
											\$2.52		
TOTAL													

Name	COST ESTIMATE ANALYSIS	NAL	<b>7SIS</b>			=	NOLLATION N	INVITATION NO./CONTRACT NO.	<u>Ģ</u>		EFFECTIVE PRICING	PRICING	DATE PREPARED	03
National Content   Conte			)				DACA 21-	-91 C-0097			DATE APRS	35	15-Apr-92	
No. F. McPhenon & F. Claim   Property   Control   Property   Control   Property   Prop	1	udy					X CODE A	CODEB	CODEC		DRAWING N	ci.	SHT OF	
Pack   Pack							OTHER.							
Pack   Courty   Courty   LABOR   LAB											ESTIMATOR	₽¥G	CHECKED BY	
Proof		Que	<del>dit</del>		IABO			EQUIPA	MENT	MATE	RIAL	TOTAL	NIddiHS	g
Secondary   Units   Mass   Units   Hiss   Price   Cost   Price   Cost   William   Mass   Miles   Mil	ECO 1 - Roof	ō 9		Ì	Total	i i		n it		, Tie	ı		Coit	Total
ASSBATTS.R-19 1 SF 0.006 \$18.53 \$0.08 \$50.38	TASK DESCRIPTION	Chrits	Meas	Ę	FIS	Price	Cost	Price	Š	Price	0		*	¥
TAL.  SAD, EGNID	FIBERGLASS BATTS, R-19	1		0.005	0.005	\$18.53	\$0.09			\$0.38		\$0.47		
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TAL  EAD, BOND  10%  UBB-TOTAL  GENCY  TAL														
EAD, BOND 15% 15% 10% 10% 10% 10% 10% 15% 15% 15% 15% 15% 15% 15% 15% 15% 15	OI DEPOTE											\$0.47		
3UB-TOTAL 10% GENCY 15%		15.94										\$0.07		
UB-TOTAL GENCY 15% TAL	DOCETT COLOR OF THE COLOR OF TH	\$ \$										\$0.05		
GENCY 15% 15% 15% 15% 15% 15% 15% 15% 15% 15%	COST SIB-TOTA	2										\$0.58		
TA.	CONTINGENCY	15%										\$0.09		
	SUBTOTAL											\$0.68		
	S&A													
	TOTAL						ļ					20.03		





ECO-1, DUCT INSULATION

# DUCT INSULATION SAMPLE CALCULATION, ECO #1 BUILDING G101

# Given:

m in the	= 80 in	- from bldg plans / survey notes
Duct Perimeter		- from bldg plans / survey notes
Duct Length	= 45 ft	- Holl blug plans, see of steel
Existing Ins. Thickness	= 0.5 in	- from survey notes
Improved Ins. Thickness	= 2.0 in	- assumed
improved his. Theratess	= $0.26$ Btuh in / ft <sup>2</sup> °F	- from ASHRAE
Ins. Thermal Cond.		- from ASHRAE
Inner Film R-Value	$= 0.22 \text{ ft}^2 \text{ °F / Btuh}$	- from ASHRAE
Outer Film R-Value	$= 0.65 \text{ ft}^2 \text{ °F / Btuh}$	
Duct TempHeating	= 90 °F	- assumed
Duct Temp. Cooling	= 55 °F	- assumed
Duct TempCooling	= 75 °F	- assumed
Amb. Temp. Winter		- assumed
Amb. Temp. Summer	= 90 °F	
Delta Enthalpy - Summer	= 15.6 Btu / lbm	- assumed
Leakage Class w/o insul.	$= 48 \text{ cfm} / 100 \text{ft}^2$	- SMACNA
Leakage Class W/O Histor.	$d = 24 \text{ cfm} / 100 \text{ ft}^2$	- SMACNA
Leakage Class w/ added inst	0.5 in	- assumed
Static Pressure	= 0.5  in. w.g.	- assumed
Gas Heater Efficiency	= 75%	- assumed
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
	= \$0.0255 / kWh	- from utility rate analysis
Electric Cost	= \$8.85 / kW	<ul> <li>from utility rate analysis</li> </ul>
Demand Cost	$= \phi 0.03 / KW$	

# Duct Surface Area:

$$(80 \text{ in } / 12 \text{ in } / \text{ ft})^*(45 \text{ ft}) = 300 \text{ ft}^2$$

# Existing Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in } / \text{ ft}^2 \text{ °F}) / (0.5 \text{ in})) = 1.92 \text{ ft}^2 \text{ °F } / \text{ Btuh}$$

# Existing U-Value:

$$1 / (0.22 + 1.92 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.36 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

# Improved Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in } / \text{ ft}^2 \text{ °F}) / (2.0 \text{ in})) = 7.69 \text{ ft}^2 \text{ °F} / \text{Btuh}$$

# Improved U-Value:

$$1 / (0.22 + 7.69 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.12 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

# Existing Leakage Rate:

$$(48 \text{ cfm} / 100 \text{ ft}^2)^*(0.5)^{0.65} = 30.6 \text{ cfm} / 100 \text{ ft}^2$$

# Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

# Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

# Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

# Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 75 \text{ °F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (91.8 \text{ cfm})(90 - 75 °F) = 2020 \text{ Btuh}$$
  
0.75

**Total** 

# Summer (electric):

Insulation

$$(0.36 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E}-5 \text{ kW / Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm / cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu / lbm}) * (5.83\text{E-5 kw / Btuh}) = 0.38 \text{ kw}$$

Total

$$(0.22 + 0.38) = 0.60 \text{ kw}$$
  
 $(0.60 \text{ kw}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$ 

# Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{°F})^*(300 \text{ ft}^2)^*(90 - 75 \text{°F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (45.9 \text{ cfm})(90 - 75 °F) = 1010 \text{ Btuh}$$
  
0.75

Total

Summer (electric):

Insulation

$$(0.12 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E-5 kW / Btuh}) = 0.071 \text{ kW}$$

Leakage

Total

$$(0.071 + 0.19) = 0.26 \text{ kw}$$
  
 $(0.26 \text{ kw}) * (4380 \text{ yrs}) = 1134 \text{ kwh}$ 

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric: (2628 - 1134 kWh) = 1494 kW - Gas: (18.3 - 7.5 MBtu) = 10.8 MBtu

**Annual Cost Savings:** 

$$(10.8 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (1494 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + .95 * 8) = \$89 / \text{yr}$$

**Estimated Construction Cost:** 

\$3.05 / ft2 of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2)^*(300 \text{ ft}^2) = \$915$$

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

EMC PROJECT: #3105.000 DATE: 15~Jul-92

FILE: ECO-1DM.WK3 PREPARED BY: CMD CHECKED BY: CEL

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW
Concenio Life. Of the		

Economic Life: 25 yrs

	DCAK			TOTAL	NW N	ANNIA	ANNUAL	TOTAL			
BLDG #	DEMAND	ELECTRIC	GAS	ENERGY	ENERGY	DEMAND	ENERGY	ANNUAL	CONST	SIR	SIMPLE
	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST		PAYBACK
	(kW	(kWh/vr)	(MBtu/vr)	(MBtu/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)	<b>S</b>		(yrs)
G735	0	3,770	32	45		\$0	\$0	\$246	\$1,020	5.0	í I
G101	0	826	9	6	\$49	\$0	\$0	\$49	\$1,020	1.0	
TOTAL	0	4,596	38	54	\$295	\$0	80	\$295	\$2,040		

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

\$3.05 / ft<sup>2</sup>

UNIT CONST COST:

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

**NEW DUCT INSULATION CONDITION** 

			$\overline{}$	Т			. T	••••	
	DELTA	ENT	156	1			-		
SUMMER	AMB	TEMP (E)	6	100	86	6	3		
	JCT	EMP (F)			52	4	3		
TER	AMB	MP TEMP II	75	2	75	75	2		
Z S	3	<b>H</b> =	l		8				
	FOTAL	LEAK (cfm)	0	2	25.5	7 00	¥.0.4		
LEAK	MIE	cfm/ 00 ff <sup>2</sup> )	C	2	15.3	45.0	13.3		
	STATIC	(in w.o.)	3 0	5	0.5	0	C.D		•
		SLASS I	c	>	24	2	77		
	S	E K K		7	0		.7		
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		# PER LENGTH	(E)	8	3 8	2	160	3	
	Č	) 9 *		G101	2 0	350		-	OIAU

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 10-JUL-92

FILE: ECO-1DG.WK3 PREPARED BY: CMD CHECKED BY: CEL

LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

UNIT CONST \$3.0

\$3.05 / 112

**NEW DUCT INSULATION CONDITION** 

\$915.00 \$508.33 \$406.67 \$915.00 TOTAL CONST COST (kW/yr) 825.7 2094.5 1675.6 3770.2 ELECTRIC **ENERGY SAVINGS** ANNUAL 6.3 17.5 31.6 (MBtu/yr) GAS (KW/yr) 134.2 531.5 425.2 ELECTRIC ANNUAL (MBtu/yr) GAS 0.03 0.10 0.12 TOTAL 8 0.10 SUMMER LEAK (KW) IMPROVED ENERGY LOSSES 0.03 0.02 0.0 INSNI (KW) 700.7 760.1 TOTAL (Btufh) 560.8 448.6 WINTER (Btu/h) LEAK 700.7 389.3 311.4 (Btu/h) INSIT TOTAL BLDG G735 G101

D-1.3.6

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT McPHERSON ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	UAL	ELECTRIC	(KW/yr)	0.096	0 3030	70707	2100.8	
	ANNUAL	GAS	(MBtu/yr)	9.4			17.4	
		TOTAL	(KW)	0.22	000	0.00	0.48	
<b>JSSES</b>	UMMER	LEAK		11			0.17	
NERGY L		INSI	<b>S</b>	0.22		0.39	0.31	
u.		TOTAL	(A)	2148.2	1	4953.0	3962.4	
	AHNITER	IFAK		4	- 1		897.3	1
	2	= 02	(British	01480	70.5	3831.4	3065 1	
	ا درات درات	; ; ;	•	5	5	6735	} }	

EMC PROJECT: #3105.000 FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL DATE: 10-JUL-92 **EXISTING DUCT INSULATION CONDITION** 

Mary   Total   Ludor	COSI ESTIMATE ANALYSIS	ANALYSIS			2	'ITATION NO.	ON TOARTHOOM NO ACCUMENTA	_		ממייים מייים			
COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & P. Gleine (1906 Shuby)   COOR P. Metherson & COOR						DACA 21 – 91	-C-0097	í		DATE APP 93		DAIEPHEMAI	
INSULATION   Page   March   Insulation   Architector   A	PROJECT Ft. McPherson & Ft. Gillem ESOS St	tudy			×	CODEA	CODEBI	CODEC		DRAWING NO		22-Apr-92	
NEBLANCK   No. 0	LOCATION Ft. McPherson & Ft Gillem					OTHER		) } }				בה	
MATERIALION   No O   Unit   May   Total   Unit   Unit   MATERIALION   Unit   MATERIALION   Unit   MATERIALION   Unit		Ougutity		a Vav						ESTIMATOR R		CHECKED BY	명
March   Marc	DUCT INSULATION	:	- -		- 1	-	HOD!	IEN!	MATE	JAL.	TOTAL	IIddIHS	S S
ALE DLUCYS  BLE BLANKET TIPE  GLASS INSLLATION (27)  1 SF 0.0053 0.0059 55.089  S1.11  S1.12  S1.13	TASK DESCRIPTION						je d	(	<del>ا</del> د			Unit	Total
BLE BLANKET TIPE GLASS INSLLATION (2)  GLASS	INSULATE DUCTS		_11	2		Cost	Price	Cost	Нисе	Cost		Ň.	₹
SOUR   SOUR													- -
Clades   Nestlation (2)   Clades   Cl	FLEXIBLE BLANKET TYPE	t	0.053		\$20.88	\$1.11			\$0.8	8	8		
TAL  BAD BOND  BAD BAD BAD BAD BAD BAD BAD BAD BAD BAD	FIBERGLASS INSULATION (2°)								9.0	9.00	35.		
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TTAL EAD, BOND E				-	-								
TTAL EAD BOND EAG ST.11 SUB-TOTAL SUB-TOTAL GENCY 1556 SOOT SOOT SOOT SOOT SOOT SOOT SOOT SOO											-		
777A.  FD. BOND  SUB-TOTAL  SUB-T													_
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TTAL													
TTAL  EAD, BOND  SUB-TOTAL  10%  SOOR  SOO				-						-			
TTAL  EAD, BOND  ELD, BOND  St. 13  St. 14  St. 15  St				-						-			
TTAL  EAD, BOND  EAD, BOND  15%  80.05  St.1.11  St.02  St.1.21  St.03  St.1.3  St.03  St.1.3  St.03													
TTAL       \$0.05       \$1.11       \$0.02         EAD. BOND       15%       \$0.01       \$0.17       \$0.02         SUB-TOTAL       10%       \$0.07       \$1.38       \$0.15         SOOR       \$1.39       \$1.30       \$2.10         SOOR       \$1.50       \$2.10       \$2.10         SOOR       \$2.10       \$2.10       \$2.10													
TTAL  EAD. BOND  EAD.				-						-			
TIAL											_		
TTAL													
TTAL         \$0.05         \$1.11         \$0.02           SUB-ND         15%         \$0.01         \$0.17         \$0.08           SUB-TOTAL         \$0.07         \$1.59         \$0.07         \$1.50         \$1.06           SOOR         \$1.11         \$0.01         \$0.01         \$0.08           SUB-TOTAL         \$0.07         \$1.50         \$1.06         \$1.05           SOOR         \$1.07         \$1.00         \$1.00         \$1.00           SOOR         \$1.00         \$1.00         \$1.00         \$1.00           SOOR         \$1.00         \$1.00         \$1.00         \$1.00           SOOR         \$1.00         \$1.00         \$1.00         \$1.00					-								
TTAL         \$0.05         \$1.11         \$0.82           EAD, BOND         \$5.01         \$0.17         \$0.82           SUB-TOTAL         \$0.07         \$1.38         \$1.08           SOOR         \$1.56         \$0.01         \$0.12           SOOR         \$1.38         \$1.03           SOOR         \$1.56         \$0.01         \$0.15           SOOR         \$1.56         \$1.00         \$1.00           SOOR         \$1.50         \$1.50         \$1.50				-									
TTAL         \$0.05         \$1.11         \$0.02           EAD, BOND         \$5.01         \$0.17         \$0.08           SUBL-TOTAL         \$0.07         \$1.38         \$0.06           SCOR         \$1.38         \$1.03           SGENCY         \$1.5%         \$0.01         \$0.15           SGOR         \$1.5%         \$0.01         \$0.15           SGOR         \$1.38         \$1.38         \$1.38           GENCY         \$1.5%         \$0.01         \$1.50				_									
TTAL         \$0.05         \$1.11         \$0.02           EAD, BOND         \$0.01         \$0.17         \$0.02           SUBL-TOTAL         \$0.01         \$0.11         \$0.08           SUBL-TOTAL         \$0.01         \$0.01         \$0.15           SOOR         \$1.38         \$1.38         \$1.38           GENCY         \$1.84         \$0.01         \$0.15				+									
TTAL         \$0.05         \$1.11         \$0.82           EAD, BOND         15%         \$0.01         \$0.17         \$0.82           SUB-TOTAL         \$0.07         \$1.38         \$0.08         \$1.03           SUB-TOTAL         \$0.07         \$1.58         \$0.01         \$0.11           \$0.08         \$1.59         \$0.01         \$0.15           \$0.08         \$1.59         \$1.03				+									
TTAL         \$0.05         \$1.11         \$0.82           EAD, BOND         15%         \$0.01         \$0.17         \$0.02           SUB-TOTAL         \$0.07         \$1.38         \$1.03           SUB-TOTAL         \$0.07         \$1.59         \$0.01         \$0.15           SOOR         \$1.03         \$1.03         \$1.03           SOOR         \$1.03         \$1.03         \$1.03           GENCY         \$0.01         \$0.15         \$0.15				-									
TTAL         \$0.05         \$1.11         \$0.08           EAD, BOND         15%         \$0.01         \$0.17         \$0.12           SUB-TOTAL         \$0.07         \$1.38         \$1.03           GENCY         15%         \$0.01         \$0.13         \$0.05           SOOR         \$1.03         \$1.03         \$1.03           SOOR         \$1.03         \$1.03         \$1.03           SOOR         \$1.03         \$1.03         \$1.03           SOOR         \$1.03         \$1.03         \$1.03				-							- -		
TTAL         \$0.05         \$1.11         \$0.82           EAD, BOND         15%         \$0.01         \$0.17         \$0.12           SUB-TOTAL         \$0.07         \$1.38         \$1.03           GENCY         15%         \$0.01         \$0.15           SOOR         \$1.03         \$1.03           SOOR         \$1.03         \$0.15													
TTAL         \$0.05         \$1.11         \$0.82           EAD, BOND         15%         \$0.01         \$0.17         \$0.12           SUB-TOTAL         \$0.07         \$1.38         \$1.03           IGENCY         15%         \$0.01         \$1.50           \$0.08         \$1.50         \$1.81					-								
EAD, BOND         15%         \$0.01         \$0.17         \$0.12           SUB-TOTAL         \$0.07         \$0.11         \$0.12         \$0.08           SUB-TOTAL         \$0.07         \$1.38         \$1.03           SOOR         \$0.01         \$0.21         \$0.15           SOOR         \$1.03         \$1.03           SOOR         \$1.50         \$1.50	BTOTAL			50.05		1		+		8			
SUB-TOTAL         50.01         \$0.07         \$0.11         \$0.08           IGENCY         15%         \$0.07         \$1.38         \$1.03           \$0.08         \$1.59         \$0.15         \$0.15	VERHEAD, BOND	15%		\$0.01		\$0.17				\$ 5.00 5.00	38.58		
SUB-TOTAL         \$0.07         \$1.38         \$1.03           IGENCY         15%         \$0.01         \$0.21         \$0.15           \$0.08         \$1.59         \$1.48         \$1.48	<b>W</b> FIT	10%		\$0.01		5				20.09	3 5		
10ENCY 15% \$0.01 \$0.21 \$0.15 \$0.15 \$0.15	OST SUB-TOTAL		-	\$0.07		8				21.50	\$0.13		
80.08	NTINGENCY	15%		\$0.01		8.08		-		3.15	£0.4		
	)TAL			80.08		64.50				2.5	3 2		

ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

LIFE CYCLE COST ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DACT FISCAL YEAR 1992 DISC ANALYSIS DATE: 07-15-92	INVESTMENT PF FT. GILLEM A21-91-C-0097	ROGRAM (EC REGION ! ENERGY	CIP) LC NOS. 4 CENS SAVINGS OPP -5 HIGH EFFI	DY: GECC CID 1.0 US: 3 ORTUNITY CIENCY N BY: KC	062 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	T (1A + 1B + 1C	- 1D)		\$ \$ -\$	33322. 1833. 2000. 0. 37155.
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL	SAVINGS, UNI	T COST &	DISCOUNTED S	SAVINGS	
UNIT COST FUEL \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(	DISCOUR	NT DIS (4) SAV	COUNTED INGS (5)
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	243. 0. 0. 0.	\$ 181 \$ \$ \$ \$	6. 15. 0. 21. 0. 26. 0. 23. 0. 16.	61 66 51 77 06	28341. 0. 0. 0.
F. TOTAL	243.	\$ 183	16.	\$	28341.
3. NON ENERGY SAVINGS (+					1102.
A. ANNUAL RECURRING (1) DISCOUNT FAC (2) DISCOUNTED S	(+/-) TOR (TABLE A) AVING/COST (3)	A X 3A1)	14.	53 <b>\$</b>	
C. TOTAL NON ENERGY	DISCOUNTED SA	vings(+)/	COST(-)(3A2+	-3Bd4)\$	16012.
D. PROJECT NON ENERG (1) 25% MAX NON A IF 3D1 IS B IF 3D1 IS		ON TEST 2F5 X .33 O TO ITEM SIR = (2	) \$ 4 F5+3D1)/1E)	9352.	
4. FIRST YEAR DOLLAR SA				LIFE))\$	2918.
5. TOTAL NET DISCOUNTED	SAVINGS (2F5	i+3C)		\$	44353.
6. DISCOUNTED SAVINGS F (IF < 1 PROJECT DO	RATIO ES NOT QUALIFY	(SIR)=	:(5 / 1E)=	1.19	
`				10 72	

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 12.73

# HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5 BUILDING 40

## Given:

Motor Horsepower = 3 hp -from field survey
Operation Hours = 8,760 hrs / yr -from field survey

Standard Motor Efficiency = 84% -from standard motor info

High Eff Motor Efficiency = 88.5% -from high efficiency motor info

Motor Load Factor = 85% -assumed

Gas Cost = \$4.67 / MBtu -from utility rate analysis Electric Cost = \$0.0255 / kWh -from utility rate analysis Demand Cost = \$8.85 / kW -from utility rate analysis

# **Existing Demand:**

$$(3 \text{ hp}) * (0.746 \text{ kw/ hp}) * (85\%) = 2.26 \text{ kw}$$

$$(84\%)$$

# Improved Demand:

$$(3 \text{ hp}) * (0.746 \text{ kw / hp}) * (85\%) = 2.15 \text{ kw}$$
  
(88.5%)

# Peak Demand Savings:

$$2.26 \text{ kW} - 2.15 \text{ kW} = 0.11 \text{ kW}$$

# Annual Electric Savings:

$$(0.11 \text{ kW})^*(8,760 \text{ hrs / yr}) = 964 \text{ kWh / yr}$$

# **Annual Cost Savings:**

$$(0.0 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (964 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.11 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + 0.95 * 8) = \$36 / \text{yr}$$

# **Estimated Construction Cost:**

\$624 / 3 hp motor -from engineer's cost estimate

# Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

# Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

# Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

# Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 75 \text{ °F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (91.8 \text{ cfm})(90 - 75 °F) = 2020 \text{ Btuh}$$
  
0.75

Total

# Summer (electric):

Insulation

$$(0.36 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E}-5 \text{ kW / Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm / cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu / lbm}) * (5.83\text{E-5 kw / Btuh}) = 0.38 \text{ kw}$$

**Total** 

$$(0.22 + 0.38) = 0.60 \text{ kw}$$
  
 $(0.60 \text{ kw}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$ 

# Improved Energy Usage:

Winter (gas):

### Insulation

$$(0.12 \text{ Btuh / ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 75 \text{ °F}) / 0.75 = 701 \text{ Btuh}$$

# Leakage

$$(1.1 \text{ Btuh / cfm °F}) * (45.9 \text{ cfm})(90 - 75 °F) = 1010 \text{ Btuh}$$
  
0.75

**Total** 

# Summer (electric):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ °F})^*(300 \text{ ft}^2)^*(90 - 55 \text{ °F})^*(5.83\text{E}-5 \text{ kW} / \text{Btuh}) = 0.071 \text{ kW}$$

Leakage

Total

$$(0.071 + 0.19) = 0.26 \text{ kw}$$
  
 $(0.26 \text{ kw}) * (4380 \text{ yrs}) = 1134 \text{ kwh}$ 

# Peak Demand Savings: 0 kW

# **Annual Energy Savings:**

# **Annual Cost Savings:**

$$(10.8 \text{ MBtu})^*(\$4.67 / \text{MBtu}) + (1494 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + .95 * 8) = \$89 / \text{yr}$$

# **Estimated Construction Cost:**

\$3.05 / ft<sup>2</sup> of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2)^*(300 \text{ ft}^2) = \$915$$

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

PREPARED BY: R. GERRANS

CHECKED BY:

FILE: ECO-5.WK3

EMC PROJECT: #3105.000

17-Jul-92

DATE:

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

 ENERGY
 DISCOUNT

 COST
 FACTOR

 Gas Savings
 \$4.67 / MBtu
 23.77 UPWG

 Electric Savings
 \$0.0255 / kWh
 15.61 UPWE

 Demand Savings
 \$8.85 / kW
 14.53 UPW

Economic Life: 25 yrs

SIMPLE PAYBACK (yrs)	9.5	141		15.1	45.0	7.0.	15.5	127	
SIR	1.7	1 1	-	0.1	7	<u>.</u>	0.1	•	4
CONST COST (\$)	\$10,132	&E 504		\$16.122	770	40,04	\$2.259		tc1':22
TOTAL ANNUAL SAVINGS (\$/yr)	\$1.106	4004	180e	\$1.071		\$200	\$146		87.31Q
ANNUAL NON- ENERGY SAVINGS (\$/yr)	0\$	2 6	2	C#		80	<b>6</b>		99
ANNUAL DEMAND SAVINGS (\$/vr)	CARE		\$141		7	\$63			\$1,102
ANNUAL ENERGY SAVINGS (\$/vr)	0200	ncoe	\$256	1400	4/00	\$137			\$1,816
TOTAL ENERGY SAVINGS	THE PERSON NAMED IN	8/	34		S	4	2 9	13	243
ANNUAL ANNUAL TOTAL SAVINGS SAVINGS SAVINGS	IMDICI/VI	0		2	<u> </u>		ין ר	0	0
BLDG # DEMAND ELECTRIC GAS ENERGY SAVINGS SAVINGS SAVINGS SAVINGS (AMBTH/VY)	(KWII/YI)	25,493	1000	10,01	26.425	700 7	5,304	3.912	
PEAK DEMAND SAVINGS	(KW)	4			4	-   -		0	<del> </del>
BLDG #		101		214	213	213	207	103	TOTAL

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

		ONER/								3			DEMAND		ELECTRIC THE CIRC
BLDG. EQUIPMENT	NOTE	UNDER		Σ	<b>EPLATE</b>		×	MEASURED	1ED	<b>FACTOR</b>	EXIST	IMPRVD	SAVINGS	HRS/	SAVINGS
_		SIZED	도	FI A	VOLTS	EFF	AMPS	ЬŁ	VOLTS	8	EFF		<b>₹</b>	YEAR	(kWh/yr)
101 HWP 1			30.0	85.0	200		9.06	0.84	203	85%	90.5%			4380	3,355
HWP 2	₽		30.0	85.0	8					85%	90.5%				
CWP 1		OVER	10.0	29.0	<b>80</b> 2		16.0	0.75		85%	87.5%				•
CWP 2		OVER	10.0	29.0	208		16.7	0.72	8	85%	87.5%				•
AHC1			2.0	0.9	208	82.5%				82%	82.5%				623
AHU 2			7.5	24.4	8					82%	86.5%	91.7%	0.31	8760	
AHU 3			5.0	15		62.5%				85%	62.5%				13,406
AHU 1 FLR 4			2.0	9		82.5%				85%	82.5%				
AHU 3 FLR 4	-		9.0	15						85%	85.5%				•
AHU 4			1.0	3.8	200					85%	77.0%				
TOTAL			102.5											L	25,493
102 AHU 1			1.0	3.0	208					85%	<b>%</b> 0' <i>L</i> 1	86.5%	0.09	8760	792
AHU 2			1.0	3.0	<b>508</b>					85%	77.0%			8760	792
			2.0												1,585
103 AHU 1			3.0	9.6	200		9.6	0.80	200	85%	84.0%	88.5%	0.12		1,009
ROOF AHU 1	No Acce		5.0							85%	85.5%				1,452
ROOF AHU 2	No Acce		5.0							85%	85.5%	89.5%			1,452
TOTAL			13.0										0.4		3,912
133 AHU 1			3.0	11.4	500					85%	84.0%	88.5%	0.12	8760	1,009
AHU 2			3.0	11.4	88					85%	84.0%				1,009
AHU 3			1.5	8.0	230			_		85%	77.0%	86.5%	0.14	8760	1,188
TOTAL			7.5										0.4		3,206
207 AHU 1			3.0	9.6	82					85%	84.0%		0.12	_	1,009
AHU 2			5.0	14.8	200	0.855				85%	85.5%				1,452
AHU 3			5.0	4	88					85%	85.5%			8760	1,452
AHU 4			သ	14.2	208					85%	85.5%	89.5%	0		1,452
TOTAL			18.0		1								90		5.364

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECONTRIBILITY Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15—Jul—92
FILE: ECO—5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

HP   FLA   VOLTS   EFF   AMPS   PF   VOLTS   FF   AMPS   FF   AMPS   PF   VOLTS   FF   AMPS   AMPS   FF   AMPS   FF   AMPS   FF   AMPS   FF   AMPS   FF   AMPS   AMPS   FF   AMPS   FF   AMPS   AMPS   FF   AMPS   FF   AMPS   FF   AMPS   FF   AMPS				OVER /								LOAD			DEMAND		ELECTRIC
Diesic   D	R DG	FOLIPMENT	NOTE	UNDER		NAME	PLATE		Ī	EASURI	ED	FACTOR	EXIST	IMPRVD	-	HRS/	SAVINGS
Hard Barrel	*	DESC	!	SIZED		₹ 2	OLTS	1	AMPS		VOLTS	8	EFF	EFF	(kW)	YEAR	(kWh/yr)
Hard Barrows	11	11			3.0	6	200					82%	84.0%	88.5%	0.12	8760	600,1
AH U 3B         2.0         6.6         2.0         6.6         2.0         6.6         8.6		H 28		OVER	15.0	64	200	0.875	27.7		208	85%	87.5%	92.4%	0.58	8760	5,050
AHU         AHU <th></th> <th>H 38</th> <th></th> <th></th> <th>2.0</th> <th>99</th> <th>200</th> <th></th> <th></th> <th></th> <th></th> <th>85%</th> <th>80.0%</th> <th>86.5%</th> <th>0.12</th> <th>8760</th> <th>1,044</th>		H 38			2.0	99	200					85%	80.0%	86.5%	0.12	8760	1,044
Harting   Fig.   Harting	_				5	14.4	230					85%	85.5%	89.5%	0.17	8760	1,452
Hart   Hart	- 9	- CIE			7.5	2	230					85%	86.5%	91.7%	0.31	8760	2,731
AHU 5         FI 14 230         SS 96         BSS 86	_	12 T			ıc.	14.4	230					85%	85.5%	89.5%	0.17	8760	1,452
AHUS         SI         144         230         ABS         85-%         89-5%         0.17         8760           AHUS         AHUS         5         144         230         ABS         85-%         85-5%         89-5%         0.17         8760           AHUS         5         144         230         0.865         208         0.865         91-7%         0.01         8760           AHUS         5         144         230         0.865         208         0.865         85-%         89-5%         0.17         8760           CMP         2         7         208         0.865         86-5%         86-5%         91-7%         0.02         4380           CMP         3         1         3.75         208         0.865         86-5%         86-5%         91-7%         0.02         4380           CMP         3         2         2         2         2         2         2         0.085         86-5%         86-5%         91-7%         0.02         4380           COND         PUMP         7         2         2         2         2         2         0.07         474         85-%         84-0%         86-5%		4 T T			) LC	4 4	330					85%	85.5%	89.5%	0.17	8760	1,452
Main Columb   Main Columb		+ C.E.			יא פ	14 4	230					85%	85.5%	89.5%	0.17	8760	1,452
ALILO   ALIL	_	9 1			on c	14.4	230					82%	85.5%	89.5%	0.17	8760	1,452
Main black   Mai		2 H			27	14.4	230					85%	85.5%		0.17	8760	1,452
CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 3         CMP 3 <th< th=""><th>_</th><th>α III</th><th></th><th></th><th>ıc.</th><th>14.4</th><th>230</th><th></th><th></th><th></th><th></th><th>85%</th><th>85.5%</th><th></th><th>0.17</th><th>8760</th><th>1,452</th></th<>	_	α III			ıc.	14.4	230					85%	85.5%		0.17	8760	1,452
CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 2         CMP 3         CMP 3 <th< th=""><th></th><th>7 QV</th><th></th><th></th><th>10</th><th>96</th><th>208</th><th>0.865</th><th></th><th></th><th></th><th>85%</th><th>86.5%</th><th></th><th>0.42</th><th>4380</th><th>1,821</th></th<>		7 QV			10	96	208	0.865				85%	86.5%		0.42	4380	1,821
CMP 3         CMP 3         F S S S S S S S S S S S S S S S S S S S		- GAVE			10	996	208	0.865				85%	86.5%	91.7%	0.42	4380	1,821
HWP 1         T 2 21         230         R5         R5         77.0%         86.5%         91.7%         0.09         4380           HWP 1         T 5 21         230         R5		3.MP.3			٥	7	208					85%	80.0%		0.12		225
HWP 2		S G/W			1 +-	3.75	208					85%	77.0%		0.09		396
HWP2 COND PUMP 1         Off 3         7.5         21         230         200         85%         84.0%         88.5%         0.12         2190           COND PUMP 2 COND PUMP 2         30         200         10         200         16         0.81         47.2         85%         84.0%         88.5%         0.12         2190         219		1 d/V			7.5	2	230					85%	86.5%	91.7%	0.31	4380	1,366
COND PUMP 1         3         9         200         16         0.81         84.0%         88.5%         0.12         2190           COND PUMP 2         106.5         200         16         0.81         472         85%         84.0%         88.5%         0.12         2190           COND PUMP 2         15.0         19.6         460         16         0.81         472         85%         86.5%         92.4%         0.45         4380           AHU 1         55.0         40         460         25.9         0.70         474         85%         91.0%         94.1%         0.92         8760           AHU 1         55.0         20         20         20         20         20         20         20         8760         86.5%         91.0%         94.1%         8760		-tWP2	₽		7.5	2	230										Ç
COND PUMP 2         3.0         9         200         16         0.81         472         85%         84.0%         88.5%         0.12         2190           TOTAL         TOTAL         450         16         0.81         472         85%         91.0%         94.1%         0.95         8780           HWP         OVER         150         19.6         460         16         0.81         472         85%         88.5%         92.4%         0.95         8780           AHU         OVER         450         460         25.9         0.70         474         85%         91.0%         94.1%         0.95         8780           AHU 1         AHU 2         20         6.2         230         30         8.5         20         30         8.5         80.0%         86.5%         0.12         8760           COND. PUMP 1         3.0         8.2         208         2.2         8.5%         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.4         2.2         3.0         8.4         2.2         3.0         8.5%         9.1         8.5%         9.1         8.5%         9.1         8.5%         9.1		COND PUMP 1			က	6	8					%CR			O. 12		707
TOTAL         TOTAL         106.5         460         16         0.81         472         85%         88.5%         92.4%         0.45         4380         239         4780         4780         478         88.5%         92.4%         0.45         4380 <th< th=""><th></th><th>COND PUMP 2</th><th></th><th></th><th>3.0</th><th>6</th><th>200</th><th></th><th></th><th></th><th></th><th>85%</th><th>84.0%</th><th>88.5%</th><th>0.12</th><th></th><th>727</th></th<>		COND PUMP 2			3.0	6	200					85%	84.0%	88.5%	0.12		727
HWP         OVER         15.0         19.6         460         16         0.81         472         85%         98.5%         92.4%         0.45         4380           AHU         COVER         40.0         49         460         25.9         0.70         474         85%         91.0%         94.1%         0.45         4380           AHU 1         3.0         9.6         200         25.9         0.70         85%         84.0%         88.5%         0.12         8760           AHU 1         3.0         8.2         208         20         20         85%         84.0%         88.5%         0.12         8760           COND. PUMP 1         3.0         8.2         208         20         85%         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.4         220         8.4         220         86.5%         84.0%         88.5%         0.12         8760           CIPIC. FAN 1         3.0         8.4         220         2.2         2.2         2.2         2.2         2.2         2.2         2.2         2.2         2.2         2.2         3.2         3.2         3.2         3.2         3.2 <th>.18</th> <th>TOTAL</th> <th></th> <th></th> <th>106.5</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>3.9</th> <th></th> <th>26,425</th>	.18	TOTAL			106.5										3.9		26,425
AHU         OVER         40.0         49         46.0         25.9         0.70         474         85%         91.0%         94.1%         0.92         8760           TOTAL         AHU 1         3.0         9.6         20.0         3.0         46.0         46.0         88.5%         0.12         8760           AHU 2         2.0         6.2         230         2.0         6.2         230         8.5%         84.0%         88.5%         0.12         8760           COND. PUMP 1         3.0         8.2         208         8.2         8.6         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.2         208         8.2         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.4         220         8.5         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.4         220         2.0         2.1         2.0         8.5%         84.0%         88.5%         0.12         8760           AHU 2         3.0         8.4         2.20         2.1         2.0         2.1         2.0         2.1         2.0	1	-WP			15.0	19.6	460		16		472				0.45		1,987
FOTAL         55.0         20 <t< th=""><th></th><th></th><th></th><th>OVER</th><th>400</th><th>49</th><th>160</th><th></th><th>25.9</th><th></th><th>474</th><th></th><th></th><th></th><th>0.92</th><th></th><th>8,044</th></t<>				OVER	400	49	160		25.9		474				0.92		8,044
Hard 1		TOTAL		2111	55.0	2									1.4		10,031
COND. PUMP 1   COND. PUMP 2   COND. PUMP 2   COND. PUMP 2   COND. PUMP 1   COND. PUMP 2   COND. PUMP 2   COND. PUMP 2   COND. PUMP 2   COND. PUMP 1   COND. PUMP 2   COND. PUMP 2   COND. PUMP 1   COND. PUMP 2   COND	$\neg$	7 17			30		Ş					85%	1_				1,009
COND. PUMP 1         3.0         8.2         208         8.5         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.2         208         8.2         208         8.5%         84.0%         88.5%         0.12         8760           COND. PUMP 2         3.0         8.4         220         20         220         220         220         85%         84.0%         88.5%         0.12         2190           CIRC. FAN 1         3.0         8.4         220         220         220         220         85%         84.0%         88.5%         0.12         2190           CIRC. FAN 1         3.0         8.4         220         20         220         21         20         0.84         21         206         85%         84.0%         88.5%         91.7%         0.33         8760           AHU 2         5         9         200         0.84         21         200         0.84         21         200         0.84         21         200         0.31         2190           COND. PUMP 1         7.5         21         200         0.84         22         20         0.84         20         20         20 </th <th></th> <th>AHI 2</th> <th></th> <th></th> <th>2.0</th> <th>6.2</th> <th>230</th> <th></th> <th></th> <th></th> <th></th> <th>82%</th> <th></th> <th></th> <th></th> <th></th> <th>1,044</th>		AHI 2			2.0	6.2	230					82%					1,044
COND. PUMP 2         3.0         8.2         2.08         8.5         84.0%         88.5%         0.12         8760           TOTAL         11.0         2.0         3.0         8.4         2.20         2.20         2.20         2.20         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.4         2.20         3.0         8.5         8.4         8.5         8.4         9.7%         9.1%         9.1%         9.1%         9.1%         9.1%         9.2         9.2         9.2         9.2         9.2         9.2         9.2         9.2         9.2         9.2         9.2         8.5         8.4         9.5         9.1%         9.2		COND PLIMP 1			3.0	8.2	208					85%					1,009
TOTAL         0.5         0.5           TOTAL         0.6         0.7         0.5           CIRC. FAN 1         3.0         8.4         220 <th< th=""><th></th><th>COND PLIMP 2</th><th></th><th></th><th>3.0</th><th>8.2</th><th>208</th><th></th><th></th><th></th><th></th><th>82%</th><th></th><th></th><th></th><th></th><th>1,009</th></th<>		COND PLIMP 2			3.0	8.2	208					82%					1,009
CIRC. FAN 1         3.0         8.4         220 <th< th=""><th>- 14</th><th>TOTAL</th><th></th><th></th><th>110</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>4,070</th></th<>	- 14	TOTAL			110												4,070
CIRC. FAN 2 Off 3.0 8.4 220 2.0 6.85 85.8 84.0% 88.5% 0.12 8760 8.1 84.0 85.8 87.5% 91.7% 0.33 8760 87.0 87.0 87.0 87.0 87.0 87.0 87.0 87.	7	CIEC FAN 1			3.0	8.4	220					82%					252
PUMP 1 7.5 21 200 0.84 21 206 86% 87.5% 91.7% 0.33 8760 87.5% PUMP 2 7.5 21 200 0.84 85.6% B6.5% 91.7% 0.31 2190 81.0% PUMP 2 7.5 21 200 91.7% 9		CIBC FAN 2	ŧ		0 6	84	8					82%					
PUMP 1         7.5         21         200         0.84         85%         84.0%         89.5%         0.23         8760           PUMP 2         7.5         21         200         31         2190         31         2190           PUMP 2         7.5         21         200         36.0         36.0         36.0         37.7%         37.0		AHI 1	<u>.</u>		10	8	8		22		206						2,908
PUMP 1         7.5         21         200         85%         86.5%         91.7%         0.31         2190           PUMP 2         7.5         21         200         86.5%         91.7%         0.31         2190           PUMP 2         3.60         3.60         1.4         1.4         1.4		AHIO			ı.	6	200	0.84				82%					2,032
7.5 21 200   85% 86.5% 91.7% 0.31 2190   1.4   1.4		COND. PUMP 1			7.5	2.	8	:				82%					683
1.4		COND PUMP 2			7.5	2	200					85%	_			_	683
		TOTAL			36.0										1.4		6,557

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15—Jul—92
FILE: ECO—5.WK3
PREPARED BY:
CHECKED BY:

														DEMAND		ELECTRIC
BLDG	BLDG. EQUIPMENT	NOTE	UNDER		NAK	NAMEPLATE	111	2	MEASURED	₹D	K	EXIST	IMPRVD	SAVINGS	HRS/	٠,
*	DESC			皇	F.	VOLTS	EFF	AMPS PF	PF	VOLTS	8	EFF	EFF	(KW)	YEAR	(kWh/yr)
512	-			5.0	14.8	200								0.17		1,452
	AHU 2			3.0	9.7						85%	84.0%	88.5%	0.12	8760	-
	TOTAL			8.0										0.3		2,461
735	AHU 1		OVER	10	30	200		23	23 0.76	204	85%	87.5%	91.7%	0.33	2190	727
	TOTAL			10.0										0.3		727
932	HWP 1			5.0	12.8	230					85%	85.5%		0.17		726
	HWP 2			3.0	6						82%	84.0%		0.12		1,009
	AHC 1			2.0	6.1	208					85%	80.0%	86.5%	0.12	4380	522
	AHU 4			1.5	4.8						82%	7.0%		0.14		1,188
<del></del>	AHU 5			5.0	14.7						85%	85.5%		0.17		726
	TOTAL			16.5										0.7		4,171

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15—Jul—92
FILE: ECO—5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

cri	EQUIPMENT	DODA I COTOR						_	-
*		こうこう		TOTAL	OH&B	PRO	TOTAL		O A
١	DESC	9	Ø		15%	10%	<b>છ</b>	15%	છ
101	HWP 1	\$1,639	\$152	\$1,791	\$269		\$2,239	\$336	\$2,575
	HWP 2								4
	CWP 1	\$750		\$856					200
	CWD	\$750		\$826					\$1,188 188
	1 T T	8359		\$427					\$614
		\$616		\$688					999 8990
		200	868	\$488	\$73	\$49	\$610	\$91	\$701
		6359		\$427					\$614
		200		\$488					\$701
		200		8360					\$517
	TATAI	100					ا		\$9,087
- 1	1010	6000						29\$	\$517
102		2003	899	8360	\$54	\$36	\$450	\$67	\$517
	N TOTAL								\$1,035
- L	1017	9964			_				\$624
3		200							\$701
		6420	9	\$488	\$73	\$49	\$610	\$91	\$701
	TATA!	2							\$2,026
133	1015 1015	9988					\$542	88	\$624
	- C-	\$366	898	\$434	\$65	\$43			
	1 c	8328							
	TOTAL								
700	7 7	8366		L					\$624
	- C	\$420							\$70
	7 E	2420				\$49		59	\$70
	2 H	\$420	898	\$488	\$73		\$610		\$70
	A104								\$2,72

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

8 8	\$80 \$129 \$91 \$91 \$91	\$3129 \$3129 \$3129 \$31 \$3155 \$3155			( <del>O</del> )	\$129 \$5014 \$501 \$501 \$501 \$501 \$501 \$501 \$501 \$501
		φ <del>φ</del>	<i>₩</i>			
	\$103 \$73 \$73 \$73 \$73	\$103 \$73 \$73 \$73 \$73 \$124 \$124 \$124	\$103 \$73 \$73 \$73 \$73 \$124 \$124 \$124 \$103 \$55 \$65 \$65	\$103 \$73 \$73 \$73 \$73 \$73 \$124 \$124 \$165 \$65 \$359	\$103 \$73 \$73 \$73 \$73 \$124 \$124 \$124 \$124 \$124 \$124 \$124 \$124	\$103 \$73 \$73 \$73 \$73 \$73 \$73 \$124 \$124 \$124 \$124 \$124 \$124 \$124 \$124
	\$688 \$488 \$488 \$488	\$68 \$48 \$48 \$48 \$85 \$85 \$85 \$85 \$85 \$85 \$85 \$85 \$85 \$8	\$688 \$427 \$826 \$826 \$826 \$826 \$427 \$434 \$434	\$688 \$488 \$488 \$488 \$488 \$488 \$427 \$427 \$434 \$434 \$434 \$434 \$434 \$434 \$434 \$43	\$688 \$488 \$488 \$488 \$427 \$688 \$688 \$689 \$689 \$689 \$689 \$689 \$689	24.34
	24 24 26 26 26 26 26 27 27 27 27 27 27 27 27 27 27 27 27 27	\$72 \$68 \$68 \$68 \$68 \$68 \$76 \$76 \$76	\$72 \$68 \$68 \$68 \$68 \$68 \$76 \$76 \$76 \$78 \$68 \$68 \$68 \$68 \$68 \$68 \$72 \$68 \$68 \$68 \$76 \$68 \$68 \$76 \$68 \$68 \$76 \$68 \$68 \$76 \$76 \$68 \$76 \$76 \$76 \$76 \$76 \$76 \$76 \$76 \$76 \$76		100   100	
0.00	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	\$ 420 \$ 420 \$ 420 \$ 420 \$ 550 \$ 550	\$420 \$420 \$420 \$420 \$750 \$750 \$616 \$366	\$420 \$420 \$420 \$420 \$720 \$750 \$750 \$750 \$750 \$750 \$750 \$750 \$75	\$420 \$420 \$420 \$420 \$420 \$750 \$750 \$750 \$750 \$750 \$750 \$750 \$75	\$420 \$420 \$420 \$420 \$420 \$750 \$750 \$750 \$359 \$366 \$366 \$366 \$366 \$366 \$366 \$366 \$36
6	16460	16 4 6 6 7 8 L S 6	7.2 7.4 7.7 7.7 7.2 7.3 7.3 7.3 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0	AHU 3 AHU 3 AHU 4 AHU 5 AHU 7 AHU 7 CWP 1 CWP 3 HWP 1 COND PUMP 1 COND PUMP 1 COND PUMP 2 COND PUMP 1	AHU 3 AHU 3 AHU 3 AHU 4 AHU 5 AHU 6 AHU 6 CWP 1 CWP 2 CWP 3 HWP 1 COND PUMP 1 TOTAL HWP AHU 1 AHU 1 AHU 1 COND. PUMP 1	AHU 3 AHU 3 AHU 4 AHU 5 AHU 6 AHU 6 AHU 7 AHU 8 CWP 1 CWP 3 CWP 3 CWP 3 CWP 3 CWP 3 CWP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1 COND PUMP 1
	~ ~ ~ ~	,	, , , , , , , , , , , , , , , , , , ,	, , , , , , , , , , , , , , , , , , ,	コココココピタチチチメスにドコにロコスス	AHU 2 AHU 4 AHU 4 AHU 4 AHU 7 AHU 7 AHU 7 AHU 1 AHU 2 AHU 2 AHU 2 COND COND COND COND COND COND COND COND

PROJECT: FO LOCATION: F

CLIENT CONT

	<u>-</u>		202			3		
	MOTOR	I ABOR	TOTAL		PROFIT	TOTAL	_	101AL
BLDG. EGUITMENT		٤	8	15%	10%	_	15%	9
DESC	•		0074		0V\$	6610	11	\$701
ALI 1	222	3			<b>}</b>			
- (	9000	600	E434		\$43		88	\$624
AHU 2	800	8	<u> </u>					¢1 305
HATAI								20,
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				1016	600	ı	L	41 188
AHI 1	\$750	2/8	82.00 88.20	4716	200	- 11		007
								\$1,188 \$1,188
1 N N					6	1		\$701
LAA/D 1	5420	899			2			
			_		443			\$624
HWP 2	9	<u></u>			2			6614
¥ 1714	\$350	898						100
- 25	3		_		CPS			\$569
AH 7	8358 —	200		_	}			410
	6420	899			\$49			-0/ <del>0</del>
MU 3		*						\$3,209
TOTAL								
AHU 1 HWP 1 HWP 2 AHU 1 AHU 5 TOTAL	\$750 \$420 \$356 \$328 \$328 \$420	\$76 \$68 \$68 \$68 \$68 \$68 \$68 \$68		6 8 4 2 8 8	88 \$73 27 \$65 27 \$64 86 \$59 86 \$59	\$124 \$73 \$65 \$64 \$59 \$73	\$124 \$83 \$1 \$73 \$49 \$65 \$43 \$59 \$40 \$73 \$49	\$124 \$73 \$65 \$64 \$59 \$73

# INSTALL HIGH EFFICIENCY MOTORS

HOURS OF OPERATION PER YEAR   A000 HRS     SAVINGS   SIMPLE   SAVINGS   SIMPLE   SAVINGS     \$14   10.6 \$1.9   8.0 \$2.9     \$14   10.6 \$1.9   8.0 \$2.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$18   9.7 \$24   7.3 \$3.9     \$25   7.9 \$34   5.9 \$5.4     \$25   7.9 \$34   5.9 \$5.4     \$108   9.7 \$24   7.3 \$3.9     \$18   6.4 \$64   4.8 \$102     \$109   \$200   \$200     \$134   5.4 \$179   4.1 \$285     \$134   5.4 \$179   4.1 \$285     \$134   5.4 \$189   5.5 \$299     \$189   8.0 \$252   6.0 \$401     \$117   15.0 \$236   11.3 \$376		MOTORS OP	MOTORS OPERATING AT FULL LOAD	FULL LOAD	ELEC. DEMAN	ELEC. COST: DEMAND COST:	\$0.0255 /kWH \$8.85 /kW			
STANDARD   PERMIUM   COST   T.   T.   COST   T.   C.   COST   T.   C.   C.   C.   C.   C.   C.   C			(1800 RPM)		HOURS	OF OPERA	TION PER YEAR			
STANDARD         PREMIUM         DIFFERENTIAL         SANINGS/ NEAR         SIMPLE FARACK         SAVINGS/ VEAR         SIMPLE PAYBACK         SAVINGS/ VEAR           6         FFICIENCY         EFFICIENCY         FCOST *         YEAR         PAYBACK         YEAR           1         77.0%         86.5%         \$1167         \$21         80         \$28         60         \$44           2         80.0%         86.5%         \$172         \$18         9.7         \$24         7.3         \$38           3         84.0%         86.5%         \$172         \$18         9.7         \$24         7.3         \$38           4         86.5%         \$172         \$18         9.7         \$24         7.3         \$38           5         86.5%         \$172         \$18         9.7         \$24         7.3         \$38           6         86.5%         \$172         \$18         9.7         \$24         7.3         \$38           86.5%         \$176         \$201         \$25         \$24         7.3         \$38           86.5%         \$177         \$300         \$4         \$64         \$64         \$64         \$64         \$68         \$1			•		2000 HRS		4000 HRS		8760 HRS	
T7.0%         86.5%         \$148         \$14         T0.0%         \$19         \$0         \$29           T7.0%         86.5%         \$16.7         \$21         \$21         \$28         6.0         \$44           80.0%         86.5%         \$172         \$18         9.7         \$24         7.3         \$39           84.0%         \$6.5%         \$172         \$18         9.7         \$24         7.3         \$38           86.5%         \$172         \$18         9.7         \$24         7.3         \$38           86.5%         \$9.5%         \$201         \$25         7.9         \$34         5.9         \$54           86.5%         \$9.17%         \$305         \$48         6.4         \$64         4.8         \$102           86.5%         \$9.17%         \$305         \$48         6.4         \$64         4.8         \$108           86.5%         \$9.24%         \$495         \$70         7.1         \$83         \$64         \$118           86.5%         \$9.24%         \$495         \$70         7.1         \$83         \$67         \$18           90.2%         \$9.4%         \$1,74         \$134         7.4         \$18 </th <th>H.P.</th> <th>STANDARD</th> <th>PREMIUM</th> <th>DIFFERENTIAL</th> <th>SAVINGS/</th> <th>SIMPLE</th> <th>SAVINGS/</th> <th>SIMPLE</th> <th>SAVINGS/</th> <th>SIMPLE</th>	H.P.	STANDARD	PREMIUM	DIFFERENTIAL	SAVINGS/	SIMPLE	SAVINGS/	SIMPLE	SAVINGS/	SIMPLE
77.0%         86.5%         \$167         \$21         8.0         \$28         6.0           80.0%         86.5%         \$178         \$18         9.7         \$24         7.3           84.0%         86.5%         \$172         \$18         9.7         \$24         7.3           86.5%         89.5%         \$201         \$25         7.9         \$34         5.9           86.5%         91.7%         \$305         \$48         6.4         \$64         4.8           86.5%         91.7%         \$305         \$48         6.4         \$64         4.8           87.5%         91.7%         \$370         \$51         7.1         \$33         5.3           90.2%         92.4%         \$495         \$70         7.1         \$33         5.3           90.2%         94.1%         \$1,042         \$134         5.4         \$179         4.1           90.2%         94.1%         \$1,042         \$141         7.4         \$188         5.5           91.7%         94.5%         \$1,214         \$187         7.7         \$210         \$25           91.7%         94.5%         \$1,743         \$193         9.0         \$255		77.0%		\$148	\$14	10.6		8.0	\$23	5.0
86.5%         \$178         \$18         9.7         \$24         7.3           84.0%         88.5%         \$172         \$18         9.7         \$24         7.3           86.5%         \$172         \$18         9.7         \$24         7.3           86.5%         89.5%         \$201         \$25         7.9         \$34         4.8           86.5%         91.7%         \$305         \$48         6.4         \$64         4.8           86.5%         91.7%         \$305         \$48         6.4         \$64         4.8           87.5%         91.7%         \$495         \$70         7.1         \$93         \$6.3           90.2%         93.6%         \$65         8.9         865         8.9         \$67         6.7           90.2%         94.1%         \$1042         \$141         7.4         \$189         \$6.1           90.2%         94.1%         \$1,214         \$157         7.7         \$210         \$6.3           91.0%         94.5%         \$1,214         \$157         7.7         \$210         \$6.8           91.7%         94.5%         \$1,743         \$193         90         \$256         6.0				\$167	\$21	8.0	\$28	0.9		3.8
84.0%       88.5%       \$172       \$18       9.7       \$24       7.3         86.5%       89.5%       \$201       \$25       7.9       \$34       5.9         86.5%       91.7%       \$305       \$48       6.4       \$64       4.8         87.5%       91.7%       \$370       \$51       7.3       \$68       5.4         88.5%       92.4%       \$495       \$70       7.1       \$93       5.3         90.2%       93.0%       \$679       \$65       8.9       \$67       6.7         90.2%       93.6%       \$646       \$98       6.6       \$131       4.9         90.2%       94.1%       \$1,214       \$157       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,743       \$193       9.0       \$257       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$256       6.0				\$178	\$18	9.7	\$24	7.3	\$39	4.6
86.5%       89.5%       \$201       \$25       7.9       \$34       5.9         86.5%       91.7%       \$305       \$48       6.4       \$64       4.8         87.5%       91.7%       \$370       \$51       7.3       \$68       5.4         88.5%       92.4%       \$495       \$70       7.1       \$93       5.3         90.2%       93.0%       \$579       \$65       8.9       \$87       6.7         90.2%       94.1%       \$729       \$134       5.4       \$179       4.1         90.2%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       \$5.8         91.7%       94.5%       \$1,743       \$193       90       \$252       6.0         92.2%       94.5%       \$2,666       \$177       15.0       \$236       6.8				\$172	\$18	9.7	\$24	7.3	\$38	4.6
86.5%         91.7%         \$305         \$48         6.4         \$64         4.8           87.5%         91.7%         \$370         \$51         7.3         \$68         5.4           88.5%         92.4%         \$495         \$70         7.1         \$93         5.3           90.2%         93.6%         \$659         8.9         86         \$131         4.9           90.2%         94.1%         \$729         \$134         5.4         \$179         4.1           91.0%         94.1%         \$1,042         \$141         7.4         \$188         5.5           91.7%         94.5%         \$1,214         \$157         7.7         \$210         5.8           91.7%         94.5%         \$1,743         \$193         9.0         \$252         6.0           92.2%         94.5%         \$1,743         \$193         9.0         \$256         6.0           93.0%         \$256         \$1,77         \$150         \$256         6.0	4,			\$201	\$25	7.9	\$34	5.9	\$54	3.7
87.5%         91.7%         \$370         \$51         7.3         \$68         5.4           88.5%         92.4%         \$495         \$70         7.1         \$93         5.3           90.2%         93.0%         \$679         \$65         8.9         \$87         6.7           90.2%         93.6%         \$646         \$98         6.6         \$131         4.9           90.2%         94.1%         \$729         \$141         7.4         \$188         5.5           91.0%         94.1%         \$1,042         \$141         7.4         \$188         5.5           91.7%         94.5%         \$1,214         \$157         7.7         \$210         5.8           92.2%         94.5%         \$1,743         \$193         9.0         \$257         6.8           93.0%         94.6%         \$2,666         \$177         15.0         \$236         11.3	7.5			\$305	\$48	6.4	\$64	4.8		3.0
88.5%       92.4%       \$495       \$70       7.1       \$93       5.3         90.2%       93.0%       \$579       \$65       8.9       \$87       6.7         90.2%       93.6%       \$646       \$98       6.6       \$131       4.9         90.2%       94.1%       \$729       \$134       5.4       \$179       4.1         91.0%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         92.2%       94.5%       \$1,743       \$193       9.0       \$252       6.0         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	<u> </u>			\$370	\$51	7.3		5.4	\$108	3.4
90.2%       93.0%       \$579       \$65       8.9       \$87       6.7         90.2%       94.1%       \$729       \$134       5.4       \$179       4.1         91.0%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	<u>*</u>			\$495	\$70	7.1	\$93	5.3		3.3
90.2%       93.6%       \$646       \$98       6.6       \$131       4.9         90.2%       94.1%       \$729       \$134       5.4       \$179       4.1         91.0%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	×			\$579	\$65	8.9		6.7	\$138	4.2
90.2%       94.1%       \$729       \$134       5.4       \$179       4.1         91.0%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	స			\$646	86\$	9.9		4.9	\$208	3.1
91.0%       94.1%       \$1,042       \$141       7.4       \$188       5.5         91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	ĕ			\$729	\$134	5.4		4.1	\$285	2.6
91.7%       94.5%       \$1,214       \$157       7.7       \$210       5.8         91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	¥			\$1,042	\$141	7.4		5.5		3.5
91.7%       94.5%       \$1,515       \$189       8.0       \$252       6.0         92.2%       94.5%       \$1,743       \$193       9.0       \$257       6.8         93.0%       94.6%       \$2,666       \$177       15.0       \$236       11.3	5			\$1,214	\$157	7.7		5.8	<u> </u>	3.6
92.2%     94.5%     \$1,743     \$193     9.0     \$257     6.8       93.0%     94.6%     \$2,666     \$177     15.0     \$236     11.3	9			\$1,515	\$189	8.0		0.9	<u> </u>	3.8
93.0% 94.6% \$2,666 \$177 15.0 \$236 11.3	7			\$1,743	\$193	9.0		6.8		4.3
	<u>p</u>			\$2,666	\$177	15.0		11.3	1	7.1

\* DIFFERENTIAL COST DOES NOT INCLUDE LABOR COSTS

ECO-7, CONTROL HOT WATER CIRCULATION PUMPS

LIFE CYCLE COST ANALYSIS SU ENERGY CONSERVATION INVESTMENT I INSTALLATION & LOCATION: FT. GILLEM PROJECT NO. & TITLE: DACA21-91-C-009 FISCAL YEAR 1992 DISCRETE PORTION ANALYSIS DATE: 07-17-92 ECONOMIC L		~~ ~ uw	DUMP CONTA		5 52 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COST E. TOTAL INVESTMENT (1A + 1B + 1	1C - 1D)			\$ \$ -\$	9868. 543. 592. 0. 11003.
<ol> <li>ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UI</li> </ol>	NIT COST	& DISC	OUNTED SAVI	NGS	
UNIT COST SAVINGS	ANNUAI	L \$ 38(3)	FACTOR(4)	SAV	COUNTED INGS (5)
A. ELECT \$ 7.47 425. B. DIST \$ .00 0. C. RESID \$ .00 0. D. NAT G \$ 4.67 233.	\$ · · · · · · · · · · · · · · · · · · ·	0. 0. 1088. 0.	14.26 16.89 14.45 11.21		35290. 0. 0. 15723. 0.
F. TOTAL 658.	\$	4265.		\$	51013.
NON ENERGY SAVINGS(+) / COST(-)					0.
A. ANNUAL RECURRING (+/-) (1) DISCOUNT FACTOR (TABLE)	A) (3A X 3A:	1)	10.59	\$	0.
C. TOTAL NON ENERGY DISCOUNTED	SAVINGS (	+)/COST	(-) (3A2+3B6	14)\$	0.
D. PROJECT NON ENERGY QUALIFICA  (1) 25% MAX NON ENERGY CALC  A IF 3D1 IS = OR > 3C  B IF 3D1 IS < 3C CALC  C IF 3D1B IS = > 1 GC	ATION TES' C (2F5 X GO TO I C SIR = D TO ITEM ECT DOES	T .33) TEM 4 : (2F5+3 ! 4 NOT QU!	\$ 166 3D1)/1E) ALIFY	334.	
D IF 3DIB IS 1 PROSES.  4. FIRST YEAR DOLLAR SAVINGS 2F3+3	3A+(3B1D/	YYRS E	CONOMIC LIF	E))\$	4265.
5. TOTAL NET DISCOUNTED SAVINGS (	2F5+3C)			•	51013.
6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUAL	(S	IR)=(5	/ 1E)= 4	1.64	
7. SIMPLE PAYBACK PERIOD (ESTIMAT	ED) S	PB=1E/4	, ·	2.58	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 7 - Hot Water Pumps

PREPARED BY: R. GERRANS CHECKED BY:

EMC PROJECT: #3105.000

DATE: 15-APR-92 FILE: ECO-7.WK3

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.70 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / KWh	11.11 UPWE
Demand Savings	\$8.85 / KW	10.59 UPW

Economic Life: 15 yrs

		SIMPLE	<b>AYBACK</b>	(yrs)	2.3
		SIR	<u>~</u>		4.6
		CONST	COST	(\$)	\$9,868
	TOTAL	ANNUAL	SAVINGS	(\$/yr)	\$4,271
ANNOAL	NON-	ENERGY	AVINGS	(\$/yr)	0\$
	ANNOAL	DEMAND	SAVINGS	(\$/yr)	0\$
	ANNUAL	ENERGY	SAVINGS	(\$/yr)	\$4,271
	TOTAL	ENERGY ENERGY	SAVINGS	(MBtu/yr)	859
	ANNOAL	GAS	SAVINGS	(kWh/yr) (MBtu/yr) (MBtu/yr)	233
	ANNUAL ANNUAL	ELECTRIC	SAVINGS SAVINGS SAVINGS SAVIN	(KWh/yr)	124,564
	PEAK	DEMAND	SAVINGS	(kW)	0
		BLDG #			101

PROJECT FLAMPMENDEN FLAMPMENDEN FLAMPMENDEN FLAMPMENDEN FLAMPMENDEN FLAMPMENDEN FLAMPMENDEN FLAMPMEND FL	A STANITE TOO	NAI VO	<u>()</u>			<b>∠</b>	IVITATION NC	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING	RICING	DATE PREPARED	H C
F. Machenson & F. Gillem ESOS Study   A F. Machenson & F. Gillem ESOS Study   A F. Machenson & F. Gillem ESOS Study   A F. Machenson & F. Gillem   A F. Gil	COSI ESTIMATE A	7	)			•	DACA 59-6	90-C-0087			DATE APR.	91	22-Apr-92	
Outrety   LABOR   Cost   Duff   Duf		è				<b>-</b> -	CODE A	X CODE B	CODEC		DRAWING NO	Ċ	SHT OF	
Outer   No. Of   Unit   MHV   Total   Unit	LOCATION Ft. McPherson & Ft Gillem						ר ה			1. = 1	ESTIMATOR	명	СНЕСКЕВВУ СВ	ਰ
No. Off Unit MrV Total Unit Hrs Price Cost Price Cost Unit Mo. Off Hrs Price Cost Price Cost Unit Hrs Price Cost Price Cost Unit Hrs Price Cost Price Cost Unit Hrs Price Cost Price Cost Unit Hrs Price Cost Price Cost Unit Hrs Price Cost Price Cost Unit Hrs Price Cos					AROB			EQUEN	TENT	MATERI	Æ	TOTAL	SHIPPING	Ŋ.
This   Moss   Unif   His   Price   Cost   Price	_	⊒l	į		otal	Cait		Unit		Chit			Unit	Total
Feb.   Feb.					Hrs	Price	Cost	Price	Cost	Price	Cost		₹	₹
E	ASS DESCRIPTION OF THE PROPERTY OF THE PROPERT	┼─												
E 1 EA 15 21/7 \$51.76 118  E 20 20 21/7 \$52.34 270  SP DPS	GEN.	2 E	Ø	5.0	10.0	21.17	\$211.70			261.0	522.00			_
Deg 1 EA 20 20 21.17 \$4234 370  Segundary Early EA 20 20 21.17 \$4234 156  The 20 20 21.17 \$4234 156  The 20 20 21.17 \$4234 156  Segundary Early	WIS	1 -	4	1.5	1.5	21.17	\$31.76			118	118.00			
DPS 1 EA 20 20 21.17 \$52.94 66 129 117 \$52.95 117 \$52.95 1129 129 129 129 129 129 129 129 129 12	STS	7		20	2.0	21.17	\$4234	_		370	370.00			
PPS	VALVE	,	\ {   <		00	21 17	\$42.34			. 99	00.99	108		
CONDUIT 6 S900.00 S900.00 S S900.00	ST/SP	-	ς .	2 2	2 4	2, 47	\$5293			129	129.00	182		
7 000058 9501 9 1 1504 00	PUMP DPS	-	4	6.5	6.3	21.17	10100		-					
\$94,00 \$128				.   .	-   -				-					
200,000 8500,000 1 150			-			- -				\$04 00	\$564.00	\$564.00		
2500.00 2515 2515 2515 2516 2516 2516 2517 2517 2518 251	WIRE AND CONDUIT	9							-			0000		_
ND 15% \$1.201	DOCODANIANG	9			-		\$900.00		-  -			20.00		
TAL SALDENID SALDENID 10% 10% 10% 10% 10% 10% 10% 10% 10% 10%			-			-								
TAL  SAD, BOND  108  108  108  108  108  108  108  10					-									
TAL.  AD, BOND  10%  10%  10%  10%  10%  10%  10%  10		-												
TAL  AD, BOND  AD, BOND  10%  10%  10%  10%  10%  10%  10%  10			-	-										-
TAL  AD, BOND  10%  10%  10%  10%  10%  10%  10%  10			-											
TAL SALZBAI SA														
TAL SAD, BOND 15% 188-1707AL 188-1707AL 188-														-
TAL SAD, BOND 15% SAD, BOND 16% S1281 S182 S182 S183 S184 S1601 S240 S148 S148 S1501			-											
TAL  FAL  SA1,281  SA0, BOND  SA0, BOND  SA1,281  SA1,281  SA1,281  SA1,281  SA1,281  SA2,0			-	-	-									
TAL  AD, BOND  ILBA-TOTAL  GENCY  GENCY  AD LER			-	-										
TAL  SAD, BOND  SAD, B				-										
TAL     \$1,281       AD, BOND     \$162       AD, BOND     \$128       LIB-TOTAL     \$1,801       GENCY     \$240       OLLER			+-											_
FAL. SAD, BOND 15% 16% 16% 16% 16% 16% 16% 16% 16% 16% 16			-											
FAL         \$1,281           SAD, BOND         15%         \$182           AD, BOND         10%         \$128           IUB-TOTAL         \$1,601         \$240           GENCY         15%         \$240				_					1					
AD, BOND         \$192         \$128	C. BTOTAL						\$1,28	-			\$1,769	7		
### ### ### ### ### ### ### ### ### ##	OVERLIEND BOND	15%			!		\$18	2			824			
SUB-TOTAL         \$1,601           GENCY         \$240           OLLER         \$240	OVERTICAL, BOXES	86	-				\$12	8			\$177			-
15% \$240 °	PHOFIL						\$1,60	-			\$2,211	₩.		
	COST SUB-TOIAL	450/					\$24	_			æ£\$	\$572		
	CONTINGENCY	g 0	-	-							\$1,100	\$1,100		_
	CONTROLLER			-					-					
											\$3,643	\$5.484		
TOTAL THIS SHEET	TOTAL THIS SHEET		-	-			\$1,84	2						

ECO-12, REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COS ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DAC FISCAL YEAR 1992 DISC ANALYSIS DATE: 07-15-92	REIE PURIIUN	Mana		17 4 17 C C C C C C C C C C C C C C C C C C		15 62 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	÷т	c - 1D)			ė.	51612. 2839. 3097. 0. 57548.
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL	COST (-) SAVINGS, UNI	T COST	r & DISC	COUNTED SAVI	NGS	
UNIT COST FUEL \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUA SAVIN	AL \$ NGS(3)	DISCOUNT FACTOR(4)	DISC	COUNTED INGS (5)
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	973. 0. 0. 302. 0.	\$ \$ \$ \$	7272. 0. 0. 1410. 0.	11.11 14.26 16.89 14.45 11.21		80794. 0. 0. 20379.
F. TOTAL	1275.	\$	8683.		\$	101174.
3. NON ENERGY SAVINGS (+						
A. ANNUAL RECURRING	(+/-)			10 50	\$	5979.
A. ANNUAL RECURRING (1) DISCOUNT FAC (2) DISCOUNTED S	TOR (TABLE A) AVING/COST (3)	A X 3A	1)	10.59	\$	63318.
C. TOTAL NON ENERGY						63318.
B IF 3D1 IS C IF 3D1B I	Y QUALIFICATION ENERGY CALC ( = OR > 3C GO < 3C CALC S = > 1 GO TO S < 1 PROJECT	2F5 X O TO I' SIR = O ITEM	.33) TEM 4 (2F5+3) 4	D1)/1E) 2.		
4. FIRST YEAR DOLLAR SA	VINGS 2F3+3A+	(3B1D/	(YRS EC	ONOMIC LIFE	))\$	14662.
5. TOTAL NET DISCOUNTED	SAVINGS (2F5	+3C)			\$	164491.
6. DISCOUNTED SAVINGS R (IF < 1 PROJECT DOE	ATIO S NOT QUALIFY	(SI	R)=(5 /	1E)= 2.	86	
7. SIMPLE PAYBACK PERIC	D (ESTIMATED)	SP	B=1E/4	3.	93	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 12 - HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 15-Jul-92 DATE:

PREPARED BY: R. GERRANS FILE: ECO-12.WK3

CHECKED BY:

14.45 UPWG 11.11 UPWE 10.59 UPW **FACTOR** DISCOUNT \$0.0255 / kWh \$8.85 / kW \$4.67 / MBtu COST ENERGY Economic Life: 15 yrs **Demand Savings** Electric Savings Gas Savings

							ANNOAL				
	PEAK	ANNOAL	ANNOAL	TOTAL	ANNUAL	ANNUAL	NON	TOTAL			
BLDG #	DEMAND	BLDG # DEMAND ELECTRIC	GAS	ENERGY	ENERGY DEMAND	DEMAND	ENERGY	ANNOAL	CONST SIR	SIR	SIMPLE
	SAVINGS	SAVINGS SAVINGS SAVING	SAVINGS	SAVINGS	SAVINGS SAVINGS SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST		PAYBACK
	(kW)	(kWh/yr) (MBtu/y	(MBtu/yr)	(MBtu/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$)		(yrs)
101	25	285,187	302	1,274	\$8,683	\$5,852	\$127	\$14,661	\$57,547 2.9	2.9	3.9

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 12 - HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	EQUIPMEN	#		UNIT COST (\$/ea)	TOTAL COST (\$)
G101					\$51,612.00
	DDC Panel		1	\$8,050.00	
	AHU		3	\$3,154.00	
	Chiller		6	\$3,577.00	
	Conv		1	\$4,384.00	
	Boiler		2	\$4,127.00	

EMC PROJECT: #3105.000

DATE: 15-APR-92 FILE: ECO-12.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

### **EQUIPMENT COSTS:**

DDC Panel	\$8,050
FCU	\$3,154
AHU	\$3,154
MZ AHU	\$9,192
Chiller	\$3,577
Conv	\$4,384
Boiler	\$4,127

COST ESTIMATE ANALYSIS	ANAL	rsis			-	NVITATION NO	INVITATION NO./CONTRACT NO.	ø		TIVE	RICING	DATE PREPARED	0
						DACA 21-	DACA 21-91-C-0097			DATE	April 92	-Apr	T
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	) Judy					X CODE A	CODE B	CODEC		DRAWING NO.	ci.	SHT OF	
LOCATION Ft. McPherson & Ft Gillem				,		, EECO EECO EECO EECO EECO EECO EECO EEC				ESTIMATOR RMG	RMG	CHECKED BY CEL	GE,
	Attorio	ŧ		I ABOR	0.0		EQUIPMENT	ENT	MATERIAL	JAI.	TOTAL	SHIPPING	9
AHU	No. O	Chit	¥ ¥	Total	Ę		Chit		Cnit			ig :	Total
TASK DESCRIPTION	Caits	Мевѕ	Cait	Hrs	Price	Sat	Price	Ş	Price	ટ્ક		Ĭ.	¥
O.L.O.		Ä	7.	1.5	21.17	\$31.76			\$118.00	\$118.00	\$149.76		
0.00		í	0	2.0	21.17	\$42.34			\$160.00	\$160.00	\$202.34		
DIS	-	5 1	100	2.0	21.17	\$42.34			\$370.00	\$370.00	\$412.34		
VALVE	- -	1	2.0	2.0	21.17	\$42.34			\$66.00	\$66.00	\$108.34		
FAN DPS	-	a	2.0	2.0	21.17	\$42.34			\$59.00	\$59.00	\$101.34		
TI MINO CONTRACTOR	4								\$94.00	\$470.00	\$470.00		
	2 4					\$750.00					\$750.00		
PROGRAMMING	٥					3							
										64 242	20.00		
SUBTOTAL						1083				\$186			
CONTINGENCY	15%					2416				\$1.429	\$2,523		
COST SUB-TOTAL		į				480,13				\$214	\$378		
OVERHEAD, BOND	15%					\$100				\$143	\$252		
PROFIT	\$					\$109				S1 787	S3 154		
SUBTOTAL						\$1,367							
						1963				\$1,787	\$3,154		
TOTAL THIS SHEET						/06,16							

PROJECT Ft. McPherson & Ft. Gillem ESOS Study													!
ı						DACA 21 9	DACA 21-91-C-0097			DATE APR. 92	35	-Apr	
	Study					X CODE A	CODE B	CODEC		DRAWING NO.	C.	SHT OF	
_						OTHER			<b></b>	ESTIMATOR RMG	RMG	CHECKED BY CEL	넔
	Attacas	À		ABOB	_		EQUIPMENT	ENT	MATERIAL	IIAL	TOTAL	SHIPPING	G
CONVERTER	No. or	Ę.	Ī	Total			Ç		Chit			TE T	Total
TASK DESCRIPTION	Units	Meas	- E	E I	Price	Cost	Price	Cost	Puce	is S		À	Š
	(	1	ď	Ç	21 17	\$211.70			261.0	522.00	734		
WTS	2	ស់ ដ	0 4	2 4	24.57	£31 76			118	118.00	150		
STS	- -	វ	0 0	5 6	21.17	45.CA2			370	370.00	412		
VALVE	- -	ត់ ដ	2 6	200	21.17	\$42.34			88	00.99	108		
ST/SP		ទី ជ	2 6	2.5	21.17	\$52.93			129	129.00	182		
PUMP UPS	-	5											
									00,00	9564.00	SECA DO		
WIRE AND CONDUIT	9								3.4	30:100			
PROGRAMMING	9					\$900.00					\$300.00		
						\$1.281				\$1,769	\$3,050		
SUBTOTAL	459/					\$192				\$265	\$458		
CONTINGENCY	3					\$1.473				\$2,034	\$3,508		
COSI SUB-IUIAL	15.0					1223				\$305	\$526		
OVERHEAD, BOND	5					\$147				\$203			
racri						\$1.842				\$2,543	\$4,384		
SUBICIAL		ļ.											
										60 540	£4 384		
TOTAL THIS SHEET						\$1,842				34,545			

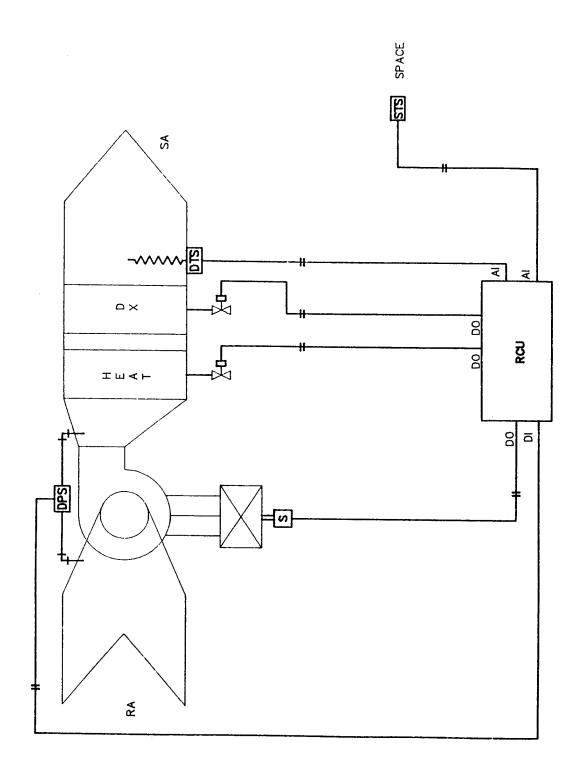
COSI ESTIMATE ANALISIS	TE ANAL	ממא			_	NVITATION NO.	INVITATION NO./CONTRACT NO.			DATE APR 92		16-Apr-92	ì
						٦٢	/200-01-01-01-01-01-01-01-01-01-01-01-01-0	0 3000		DRAWING NO		SHT	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study	SOS Study					X CODE A	SOUP B					; ;	
LOCATION Ft. McPherson & Ft Gillem						, אפריים היים היים היים היים היים היים היים ה			1	<b>ESTIMATOR RMG</b>	RMG	CHECKED BY CEL	핂
111 A 234		Custific		ABOR			EQUIPMENT	ENT	MATERIAL	IAL	TOTAL	SHIPPING	ဗ
	No. O	: I	¥H.	Total	1		te .	170	Cart	Ş		֓֞֞֞֞֞֞֓֞֞֞֓֓֓֞֞֓֓֓֓֞֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓	Total X
TASK DESCRIPTION	Cuits	Meas	Ę.	Hrs	Price	Cost	Рисе	is S	Palle	3			
0.10		A FA	7.	6.0	21.17	38			118	472.00	557		
010			200	0.9	21.17	2			160	480.00	₹		
210		5 6	000	4.0	21 17	42			370	740.00	782		
VALVE			2 4	5,0	21.17	28			150	600.00	685		
DAMPEH		5 5	3 6	200	21 17	7			98	99.00	87		
SI/SP		_	2 0	200	21.17	23			29	59.00	8		
FAN DPS			1	2									
	-												
WIRE AND CONDUIT	15								\$94.00	\$1,410.00	\$1,410.00		
D BOOGBAMMING	15	10				\$2,250.00					\$2,250.00		
		-											
		-											
						£2 568				\$3,827	\$6,395		
SUBTOTAL	450	-				\$385				\$574	\$959		
CONTINGENCY	2					\$2,953				\$4,401	\$7,354		
OVERHEAD BOND	15%					\$443				099\$	\$1,103		
PBOEIT	10%	9				\$235				25 25	\$735		
SUBTOTAL						\$3,691				\$5,501	261,63		
		-											
						53 691				\$5,501	\$9,192		

CHILLER   Columnity   CARDR   Cost   Frice   Cost	COST ESTIMATE ANALYSIS	ANA	LYSIS				INVITATION NO.	INVITATION NO./CONTRACT NO.			EFFECTIVE PRICING	PICING	DATE PREPARED	0
Continue	١						DACA 21 9	1-C-0097			DATE APR. 92	35	16-Apr92	
CHILER	PROJECT Ft. McPherson & Ft. Gillem ESOS & LOCATION Ft. McPherson & Ft Gillem	Study					1 1	CODE B	CODEC		DRAWING NO.	o.	SHT OF	
CAHLLER							' 			-	ESTIMATOR RMG	RMG	CHECKED BY	됭
DESCRIPTION  Lunis Meas Unit MH7 Total Unit MR7 Total Unit DESCRIPTION  DPS  1 EA 26 100 21.17 42  DPS  1 EA 26 25 21.17 21  DPS  1 EA 10 20 21.17 42  DPS  PRELAY  2 EA 10 20 21.17 42  DPS  PRELAY  RAMARING  6 A 10 20 21.17 42  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17 A2  CAST OF A 10 20 21.17	CHILLER	Ō	Jantity		LABC	Æ		EQUIPM	ENT	MATEF	3IAL	TOTAL	SHIPPING	Š
DPS  TAL  TAL  TAL  TAL  TAL  TAL  TAL  TA	TASK DESCOIPTION	9 - N			Total	C	1	E C		֖֖֓֞֞֞֞֞֟֓֓֓֓֓֟֓֓֓֓֓֟֟ ֖֓֞֞֞֞			5.5	Total
DPS  SHELAY  S	IASK DESCRIPTION	5			E S	1 200	Cost	Рпсе	Set	920	S S		¥	ž
Design	WTS			5.0		<u> </u>				261	522.00	564		
1 EA   2.5   2.17   2.1   2.	ST/SP			2.0						98	00:99	87		
SheLAY   2 EA 1.0 2.0 21.17 4.2	PUMP DPS		_	2.5	2.5					129	129.00	150		
MD CONDUIT  AMMAING  F  AMMAIN	STATUS RELAY		-	1.0	2.0					8	180.00	222		
ND CONDUIT   6   \$500.00														
TAL   SI   SS   SS   SS   SS   SS   SS   S	THI CNCC CNA BRIW	-	u							00 704	9564 00	9564		
TAL  GENCY  EAD, BOND  TAL  TAL  SUB-TOTAL  EAD, BOND  TAL  TAL  TAL  TAL  TAL  TAL  TAL  TA		-	0 0							3	90.40C#	00.40C#		
TAL  GENCY  SUB-TOTAL  EAD, BOND  15%  TAL  STAL   COLORAMINING		0				\$300.00					\$300.00			
TAL GENCY 3UB—TOTAL EAD, BOND 10% 10% 110% 110% 110% 110% 110% 110%			-											
TAL  EAD, BOND  TAL  TAL  TAL  TAL  TAL  TAL  TAL  TA			-											
TAL  GENCY 3UB-TOTAL  EAD, BOND  10%  TAL  TAL  SALEST  TAL  TAL  SALEST  TAL  SALEST  TAL  TAL  SALEST  TAL  SALEST  TAL  SALEST  TAL  SALEST  TAL  SALEST  TAL  TAL  SALEST  TAL  TAL  SALEST  TAL  TAL  SALEST  TAL  TAL  SALEST  TAL  TAL  TAL  TAL  TAL  TAL  TAL  T														
TAL  GENCY 3UB-TOTAL  EAD, BOND 10%  TAL  TAL  TAL  TAL  THE SHEFT			-											
TAL.  ITAL.  GENCY  SUB-TOTAL  EAD, BOND  10%  TAL.  STAL  S														
TAL  GENCY  SUB-TOTAL  EAD, BOND  TAL  TAL  THE SHIFT					-									
TAL  GENCY  3UB-TOTAL  EAD, BOND  15%  10%  TAL  TAL  10%														
TAL.  GENCY  3UB-TOTAL  EAD, BOND  15%  16%  TAL  STAL  10%														
TAL.  GENCY  3UB-TOTAL  EAD, BOND  15%  16%  17AL  17AL														
TAL. GENCY 15% 6AD, BOND 10% 10% 11% 11% 11% 11% 11% 11% 11% 11%														
TAL.  IGENCY  SUB-TOTAL  EAD, BOND  TAL  STAL  S														
TAL IGENCY 15% SUB-TOTAL EAD, BOND 10% TAL THIS SHIFT														
TAL  GENCY  3UB—TOTAL  EAD, BOND  15%  10%  TAL  S  117AL  S  117AL  S  THIS SHIFFT														
TAL.  GENCY 15%  SUB-TOTAL  EAD, BOND  TAL  TAL  S  TAL  S  THE SHEFT														
TAL.  IGENCY 15% 15% SUB-TOTAL 5 EAD, BOND 10% 10% TAL 5														
GENCY	SUBTOTAL						\$1,027				\$1,461	\$2,488		
SUB-TOTAL	CONTINGENCY	159	اود				\$154				\$219	\$373		
EAD, BOND 15%  TAL 10%  THIS SHEET	COST SUB-TOTAL		_				\$1,181				\$1,680	\$2,861		
TAL 10%	OVERHEAD, BOND	159	ور				\$177				\$252	\$429		
	PROFIT	5	اور				\$118				\$168	\$286		
	SUBTOTAL						\$1,476				\$2,100	\$3,577		
			_											
					Ī									
	TOTAL THIS SHEET						\$1,476				\$2,100	23,577		

Contact   Cont	Column   C	COST ESTIMATE ANALYSIS	E ANALYSIS	10		=	NVITATION NO.	INVITATION NO /CONTRACT NO	Ċ		DATE APR. 92	92	Ap	
Control   Cont	Section   Property							1-C-009/	CODEC		DRAWING NC	ci.	SHT OF	
Courties   Courties	Marie   Mari	- 1	OS Study				- i		<u> </u>					ī
Columnity   Colu	Column   C	HOUECI TI MCFIIII A I CHILD					OINER				ESTIMATOR	RMG	CHECKED BY	
ROLERY         LOCALITY         LARCH MARIA (LARCH MARIA) (	ROLETY         Operation March Interpretation         ACCOUNT MARK TOWN LONG TOWN LON	COALIGN TE MEI HELEN TO THE						di icu	MENT	MATER	HAL	TOTAL		1000
No Continue	No.   Mark   M	BOILER	Quantity		LABC			- Init		Cnit			֓֞֞֜֓֓֓֓֟֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓	5 \$
No comparison   Comparison	NOTICESCHIPTION   Unite   Mass   Unit   115				Total	֓֞֞֞֓֓֓֞֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓	Cost	Price	Sost	Price	Cost		À	
PDFS	PDFS  To EA 1.5 1.6 1.17 2.1 16 182.00  PDFS  To EA 2.5 2.6 2.1.7 2.1 16 182.00  PDFS  EAD CONDUIT  TO ENERAY  GRAMMING  TATTHIS SHEET  TATTHIS SHEET  TATTHIS SHEET  TATTHIS SHEET  TO SHEEK  TO SH	TASK DESCRIPTION	-+	_L	2	2								_
PER CANDINITY CELEGRAPH CONTRICTALL THIS SHEET CHARLES WERE CONTRICTALL CELEGRAPH CELE	PDFS  PDFS			;		2, 47	C7			261	522.00			
1   EA   1.5   1.1   2.1   2.1   1.2   1	1 EA 15 15 15 17 21   120	WITS		5.0		21.17	1 6			118				
P P P P P P P P P P P P P P P P P P P	Fig. 20			1.5		1	2		-	98				
DPS SPELAY SPELA	SheLAY   1 EA 2.5   2.1.77   4.2   9.0   180.0	818		2.0			7.7			138	 			
Column	DUIT   2 EA   10   2.0   21.17   42   25.20	ST/SP	-	2.5			22			8	_			
Salution   Salution	Section   Sect	PUMP DPS		10		_			-	8	_			
1	1	STATUS RELAY	+-	-										
1.	11.			-					+	18				
1. 15% 2500 251 251 251 251 251 251 251 251 251 251	100		-	-		_				3		•		-
1. 15% \$1,198 \$207 \$1,198 \$1,223 \$1,198 \$1,172 \$1,284 \$1,273 \$1,198 \$1,172 \$1,198 \$1,172 \$1,1	16-56  16	WIRE AND CONDUIT	\ \ \	+	-		\$1,050.00				-	50,		_
OTAL 15% \$1,198 \$2.251 \$30 \$1.074 \$1.076 \$1.076 \$1.076 \$2.2405 \$31.077 \$2.077 \$2.005 \$2.005 \$31.077 \$2.005 \$2.005 \$31.077 \$2.005 \$31.077 \$2.005 \$31.077 \$31.07	OTAL 15% \$1.198 \$1.673 \$2.00 \$1.00 \$	BAMMING	7	-	-									
OTAL 15% \$1136 \$1167 \$207 \$1180 \$118	T 15% \$1,198 \$1,164 \$201 \$1,164 \$201 \$2,167 \$3 \$3,167 \$3 \$3,167 \$3 \$3,167 \$3 \$3,167 \$3 \$3,167													
OTAL 15% \$1.196 \$1.196 \$2.807 \$1.80 \$2.405 \$3.100 \$	\$ 1925 \$ 1907 \$ 1928 \$ 1930 \$ 1930								-					
OTAL  ND  15% 15% 15% 15% 15% 15% 15% 15% 15% 15	15% \$1,172 \$1,172 \$2,405 \$3				-									-
OTAL  NID  1554  1555  1554  1554  1554  1555  1554  1554  1555  1554  1555  1554  1555  1554  1555  1554  1555  1554  1555  1555  1555  1556  1	L 15% \$1,198 \$1,172 \$1,197 \$2,2405 \$2,1405 \$2,													+
OTAL 15% \$11,722 \$1,722 \$2,405 \$5	L 15% \$1,196 \$251 \$251 \$251 \$251 \$251 \$251 \$251 \$251			+										-
OTAL 15% \$1,198 \$1,178 \$1,074 \$2,1024 \$3  OTAL 15% \$1,378 \$1,924 \$3  OTAL \$207 \$1,378 \$1,924 \$3  OTAL \$207 \$1,378 \$1,924 \$3  OTAL \$207 \$1,924 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3  OTAL \$22,405 \$3	L 15% \$1,198 \$2507 \$1,98 \$1,98 \$1,98 \$2,405 \$8 \$1,722 \$ \$1,722 \$ \$2,405 \$8 \$1,722 \$ \$1,722 \$ \$2,405 \$8 \$1,722			-	-	-								+
OTAL 15% \$1,198 \$1,198 \$251 \$251 \$251 \$251 \$251 \$251 \$251 \$251	L 15% \$1,198 \$227 15% \$1,378 \$130 10% \$1,378 \$138 110% \$1,378 \$138 110% \$1,372 \$138 110% \$1,722 \$2,405 \$			1	-	-	-							+
OTAL 15% \$1,198 \$251 \$251 \$251 \$251 \$251 \$251 \$251 \$251	L 15% \$1,196 \$251 \$251 \$251 \$251 \$252 \$251 \$252 \$252			+										+
OTAL 15% \$1,198 \$1,673 \$201  OTAL \$1378 \$1,924 \$5  NID 15% \$1,378 \$1,924 \$5  NID 10% \$1,722 \$2,405 \$5  NHEET \$1,722 \$2,405 \$5	L 15% \$11,98 \$251 \$251 \$251 \$251 \$251 \$251 \$251 \$251			+										-
OTAL 15% \$1,198 \$1,198 \$1,198 \$1,1924 \$1,1924 \$1,1928 \$138 \$1,1928 \$1,	L 15% \$11,198 \$251 \$251 \$251 \$251 \$250 \$1,198 \$2,207 \$192 \$2,105 \$1,1722 \$1,1722 \$2,1405 \$1,1722 \$1,17			-										-
OTAL     \$1,198     \$1,673     \$1       OTAL     \$180     \$1,224     \$1,924     \$1       NMD     \$1,378     \$1,924     \$1       NMD     \$1,372     \$1,922     \$2,405     \$2       SHEET     \$1,722     \$2,405     \$2	L 15% \$1,198 \$1,172 \$251 \$251 \$251 \$251 \$251 \$251 \$251 \$25				-	-								-
ST, 198     \$153       OTAL     \$1,378     \$289       ND     \$1,378     \$289       ND     \$138     \$192       ST, 222     \$192       ST, 722     \$2,405     \$2,405       SHEET     \$1,722     \$2,405     \$2,405	15%			-					-		21.67			
OTAL     \$180     \$1,924     \$       OTAL     \$1,378     \$289       ND     \$1,722     \$192       ND     \$1,722     \$2,405     \$       SHEET     \$1,722     \$2,405     \$	15% \$1,378 \$1,924 \$ \$1,278 \$1,924 \$ \$2,899 \$1,722 \$1,922 \$2,405 \$1 \$1,722 \$1,922 \$2,405 \$1,922 \$2,405 \$1,922 \$1,92						\$1,19	8	-		\$25		×	_
OTAL     \$1,378     \$289       NID     \$1,722     \$1,92       SE,405     \$2,405       SHEET     \$1,722     \$2,405	\$1,378 \$1289 \$2890 \$1,920 \$1192 \$1,722 \$2,405 \$1 \$1,722 \$2,405 \$1	SUBTOIAL	159%				\$18	9	+		19		22	-
\$136 \$138 \$1,722 \$1,722 \$1,722 \$2,405 \$1	\$207 \$192 \$136 \$136 \$2.405 \$5 \$1.722 \$2.405 \$5 \$2.405 \$5 \$1.722	CONTINGENCY					\$1,37	80			823		35	
AD, BOND     \$138     \$152       TAL     \$1,722     \$2,405       THIS SHEET     \$1,722     \$2,405	\$138 \$1,722 \$1,722 \$2,405 \$2	COST SUB-TOTAL	450			-	ផ	77			4		S	
TAL THIS SHEET  TAL  \$1,722  \$1,722  \$2,405	\$1,722 \$1,722 \$1,722	OVERHEAD, BOND	82	-	-		\$13	92			100		2	-
\$1,722	ET \$1,722 \$2,405	PROFIT	R	-	-		\$1,72	24			#176			
\$1,722	\$1,722 \$2,405	SUBTOTAL		-	-					+				
\$1,722	51,722										77 63		72	
	13			-			51,72	Ø	_	-	# Type			
	DAFORM 618-R APR 85	TOTAL THIS SHEET			-									

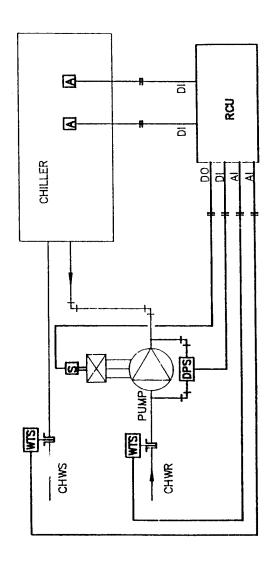
CODE C   DRAWING NO. SHT OF	COST ESTIMATE ANALYSIS	NALY	SIS			<b>∠</b>	IVITATION NO./CONTRAC	INVITATION NO./CONTRACT NO. DACA 21-91-C-0097			EFFECTIVE PRICING DATE APR. 92	RICING 12	AP	Ω
P. McPhenson & F. Galem  DDC PANNEL.  No. Outmany  DDC PANNEL  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL.  No. Outmany  DDC PANNEL  No. Outmany  DDC PANNEL  No. Outmany  DDC PANNEL  No. Outmany	- 1	udy					1 1	CODE B	CODEC		DRAWING NO	ď		
Continue   Continue							O HEX			1 -	ESTIMATOR	3MG	CHECKED BY	EF
Links   Mass   Link   From   Link   From   Link		0			a Ca v			EQUIPM	FI	MATER	IIAL	TOTAL	NIAdiks	g
With   Water   Link   Hire   Cost   Price   Cost   Price   Cost   With   With   Cost   Price   Cost   With   With   Cost   Cos		S Cas	ury Linit		Total			Unit		Unit			Z Z	Total
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TAL         TAL         S840           GENCY         S6,440           SUB-TOTAL         \$56,440           SAD, BOND         15%         \$644           SAD, BOND         10%         \$644           TAL         \$8,050           THIS SHEET         \$8,050		-									\$5,600			
GENCY         15%         \$6,440           SUB-TOTAL         \$6,440           SAD, BOND         10%         \$644           TAL         \$8,050           THIS SHEET         \$8,050	SUBTOTAL			+							\$840	ļ		
NUB-TOTAL         \$15%	CONTINGENCY	15%									\$6,440			
SAD, BOND         15%         \$644           TAL         \$8,050           THIS SHEET         \$8,050	COST SUB-TOTAL										996\$			
TAL \$88,050   TA	OVERHEAD, BOND	15%									\$644			
TAL THIS SHEET \$8,050	PROFIT	5		1							\$8.050			
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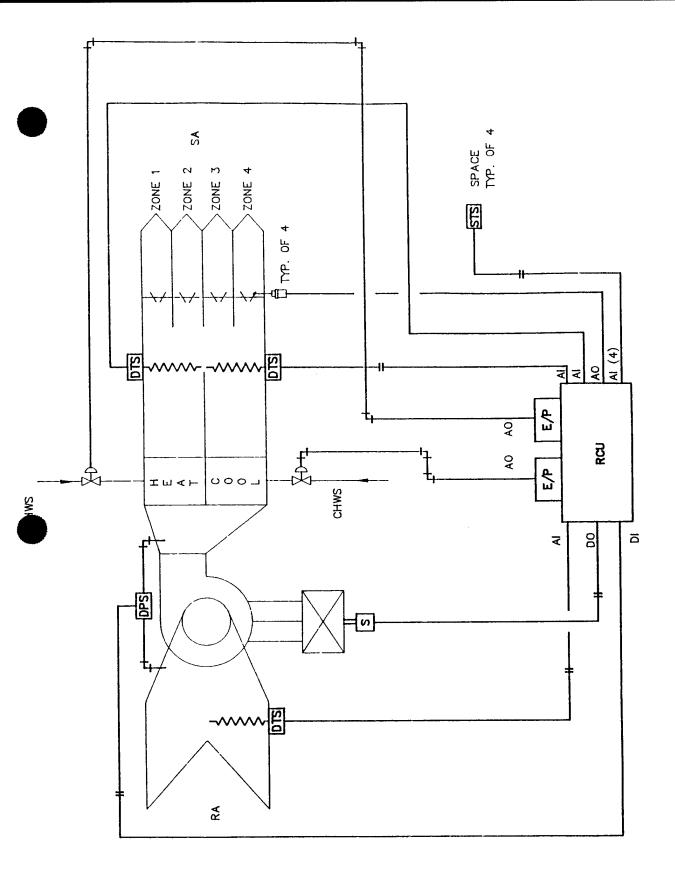
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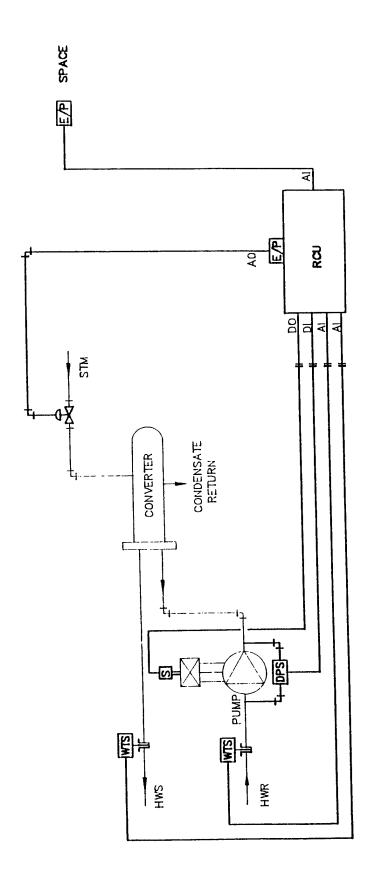
TYPICAL SINGLE ZONE AHU

TYPICAL AHU

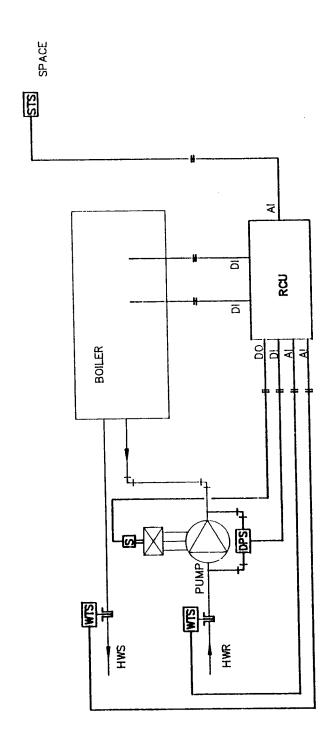




TYPICAL MULTIZONE AHU



TYPICAL STM/HW CONVERTER



	E	М	С	Ε	NGINE	E	RS, II	V	C.
Denver	•	Cold	orad	0	Springs	•	Atlanta	•	Germany

JOB FT.	MCPHERSON/GILLEM	ESOS STUDY
SHEET NO	EMC#3105.000	OF
		DATE 7/21/92
CHECKED BY	714	DATE
SCALE	-	

### LABOR SAVINGS:

An estimated 6 hours per year labor (non-energy) savings were taken due to a reduction in temperature (too hot-too cold) related services calls.

(6 hours per year per building) x \$21.16 per hour = \$127 per year per building



FISCAL Y.	EAR 1992	E COST ANALYSIS ATION INVESTMEN TION: FT. GILLE : DACA21-91-C-O DISCRETE PORTI 02-92 ECONOMIC	ON NAME: ECO-	14A RADIANT HE	AT	5 5 SURVEY
1. INVES A. C B. S C. D D. S. E. T	ONSTRUCTTON	COST E COST MENT (1A + 1B +	- 1C - 1D)		\$ 1 \$ -\$ \$ 1	49057. 8199. 8944. 0. 66200.
2. ENERG	Y SAVINGS ( YSIS DATE A	+) / COST (-) NNUAL SAVINGS,	UNIT COST & D	ISCOUNTED SAVI	ngs	
		OST SAVINGS (1) MBTU/YR(2				
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F. To	OTAL	2906.	<b>\$</b> 16089	•	\$ 2	10059.
		GS(+) / COST(-)				
A. ANI	NUAL RECURR	ING (+/-) FACTOR (TABLE ED SAVING/COST	A)	10.59	\$	0.
		RGY DISCOUNTED				
ממ ח	OJECT NON E 1) 25% MAX 1 A IF 3D B IF 3D C IF 3D	NERGY QUALIFICA NON ENERGY CALC 1 IS = OR > 3C 1 IS < 3C CALC 1B IS = > 1 GC 1B IS < 1 PROJE	TION TEST (2F5 X .33) GO TO ITEM 4 SIR = (2F5) TO ITEM 4	\$ 6931 +3D1)/1E)	.9.	
4. FIRST	YEAR DOLLA	R SAVINGS 2F3+3	A+(3B1D/(YRS	ECONOMIC LIFE)	)\$	16089.
		NTED SAVINGS (2				10059.
6. DISCO	UNTED SAVING < 1 PROJECT	GS RATIO DOES NOT QUALI	(SIR)=(5	/ 1E)= 1.2	16	
7. SIMPL	E PAYBACK P	ERIOD (ESTIMATE	SD) SPB=1E/	4 10.3	13	

### RADIANT HEAT SAMPLE CALCULATION, ECO #14 **BUILDING 512**

### Given:

Gas Savings

Analysis based on "Development of Radiant Heating Economic Evaluation Methods," see attached factors page C-14.2.3

Gas Savings Factor = 1,329 Mbtu per 149,300 sq. ft

= .00890

Electric Savings Factor

Analysis based on computer simulation of building 207, fan electric use, see page

Electric Savings Factor = 155,200 kWH per 149,3300 sq. ft = 1.04

Demand Savings Factor = 0.0 kW

Gas Cost = \$4.67 / MBtu - from utility rate analysis
Electric Cost = \$0.0255 / kWh - from utility rate analysis
Demand Cost = \$8.85 / kW - from utility rate analysis

Peak Demand Savings:

 $(120,327 \text{ ft}^2)^*(0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$ 

**Annual Energy Savings:** 

- Electric:

- Gas:

 $(120,327 \text{ ft}^2)^*(0.0089 \text{ MBtu} / \text{ft}^2) = 1,071 \text{ MBtu}$  $(120,327 \text{ ft}^2)^*(1.04 \text{ kWh}/\text{ft}^2)$  = 125,425 kWh

**Annual Cost Savings:** 

(1,0712 MBtu)\*(\$4.67 / MBtu) + (125,425 kWh)\*(\$0.0255 / kWh) + (0.0 kW)\*(\$8.85 / kW)\*(4 + .95 \* 8) = \$8,200 / yr

**Estimated Construction Cost:** 

\$0.588 / sq. ft.  $(120,327 \text{ ft}^2 * (0.588) = $70,786$ 70,786 + (70,786 \* .055 SIOH) + (70,786 \* .06 DESIGN) = 78,926

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE:

DATE: FILE: PRPARED BY: CHECKED BY:

#3105.000 09/02/92 RADIANT.WK3 DENNIS JONES

	ENERGY	DISCOUNT	SAVINGS
	COST	FACTOR	FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG	0.00792 MBtu/ft2
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	11.11 UPWE	1.03965 kWh/ft2
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW	0.00000 kW/ft2
ECONOMIC LIFE	15 YRS		

	ANNUAL	ANNUAL ANNUAL	Ž	TOTAL	ANNOAL	ANNUAL	ANNOAL	TOTAL			
SUILDING FLOOR	DEMAND	DEMAND ELECTRIC	MAT	ENERGY	ENERGY	DEMAND	NON-ENE	ANNUAL	CONST.		SIMPLE
NUMBER AREA	SAVINGS	SAVINGS SAVINGS	S	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST	SIR	PAYBACK
(ft2)	(kW)		(MBtu)	(MBtu)	<b>(%</b> )	<b>(</b> 8)	<b>⊕</b>	( <del>\$</del> )	( <del>\$</del> )		(YRS)
207 149,300	0	155,220	1,183	1,712	9,481	0	0	9,481	97,930	1.3	10.3
400 76,623	0	79,661		879	4,866	0	0	4,866	50,259	1.3	10.3
	0	28,544	217	315	1,743	0	0	1,743	18,009	1.3	10.3
	0	263,425	2,007	2,906	16,090	0	ō	16,090	166,198	1.3	

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:

09/02/92 RADIANT.WK3 DENNIS JONES #3105.000

	ш.	_		
DATE:	FILE	PRPARED BY:	CHECKED BY:	

G207		
OPERATIVE TEMPERATURE	TO	65 F
BUILDING LOAD COEFFICIENT	BLC	70,320 Btu/F/hr
AVERAGE HEAT GAIN	Qg(G)	119,860 Btu/hr
CONVENTIONAL SYSTEM EFFICIENCY	Ecc(CEC)	75%
RADIANT EFFICIENCY	RAD	55%
FLOOR AREA	ĄF	149,300 ft2
RADIANT COMBUSTION EFFICIENCY	Ecr(CER)	85%

DAYS T DAYS T (F-day) ((	-	CCTOR 7, Eq-13	CORR DEGR DAYS DAYS	12 (N. H	RADIANT FACTOR M, Eq-17 [H]	NDOOR   C   C   C   C   C   C   C   C   C	C C FACTOR C, Eq-13	CORRECTED HEATII DEGREE ENERG DAYS USAGI (Fday) (MBtu) DDm, Eq12 L,Eq	HEAT ENER USAG (MBtu		Variable,Equation Column
	50	4 4	488		0.184	63	4 4	431	_		
147	92 92 93	441	357 81	803 182	0.184	65 4 55	441	322 88 88	640 176	163	
	813	. w	00	000	0.184	79 99	ומימ		00	000	
	8 82	9 9	00	00	0.184	89	വ	00	00	00	
	77	დ 4	23 0	52	0.184	99	<b>α</b> 4	<u> </u>	0 08	(58)	
417	55 48	4 4	375 601	844 1,353	0.184	63	4 4	337 529	669 1,050	175	
			2,557	5.753				2,302	4.571	1,183	

	EMC #3105.	000 Ft. McPherson/	Gillem ESOS
	SHEET NO	OF	
E M C ENGINEERS, INC.	CALCULATED BY	CEL DATE	9/2/92
Denver • Colorado Springs • Atlanta • Germany		DATE	
	SCALE		
SAMPLE CALCULATION  Column A: JAN, the month January Column B: 31, Nm, number of days is Column C: 636, Degree days based on Column D: 47, Outside air temperatus Column E: 4, Correction Factor, C, I Column F: 659, Correct Degree Day b Column G: 1518, Monthly energy const Column H: ·184, Radiant factor, M, Column I: 62, Indoor air temp oF, Ta Column I: 4, Correction Factor, C, Column K: 554 Column C: 1101 Column C: 1101 Column M: 321 Savings, column G mi  Nm [A]  Nm [B]  Tosa [D]	t 650F (last number in the oF Equation 13, page C- pase, DDm, Equation umption, L, Equation Equation 17, page C- a, Equation 16, page Equation 13, page C- pase, DDm, Equation umption, L, Equation	14.2.5 12, page C-14.2.5 14, page C-14.2.5 14.2.7 C-14.2.6 14.2.5 12, page C-14.2.5	
JAN 31 636 4  C, Eq-13  [E]  1.339*(0.00387*\$DDA-2.77E-07*\$DDA^2)*@EXP(-((\$TO-\$G/\$BI			
, , ,	•	•	
DDm, Eq-12 [F]		L,Eq-14 [G]	
@MAX(\$B26*(\$TO-\$G/\$BLC-\$D26+E26),0)	+\$BLC*F26*24/\$C		
M, Eq-17 [H] +\$RAD/\$AF/1.22*(0.35+0.35*0.64/0.58)*\$BLQ*\$CER	Ta,Eq-16 +\$TO-(H26/(H26	[ <b>I</b> ] 5+1))*(\$TO-D26-\$G/\$BLC)	
C, Eq-13 [J]			DDm, Eq-12 [K]
39*(0.00387*\$DDA-2.77E-07*\$DDA^2)*@EXP(-((126 <b>-\$</b> G/\$B)	LC-D26+20y16.23) ^ 0.1)	@MAX(\$B26*(126-\$G/\$BL	.C-\$D26+J26),0)
L,Eq-14 [L]	[G]-[L] [M]	D-1.7.4A	
+\$BLC*K26*24/\$CER/1000000	+G26-L26		

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO-14: RADIANT HEAT

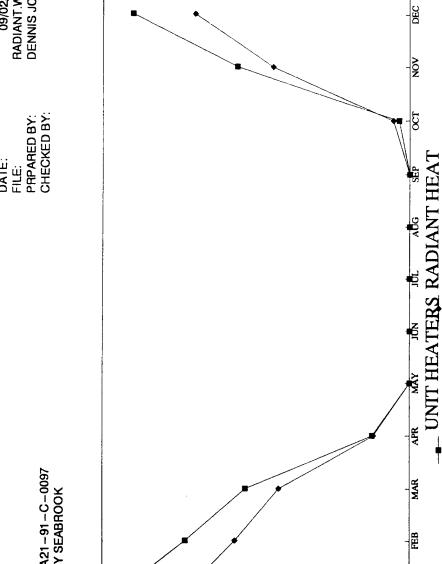
CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

1500

EMC PROJECT: DATE:

FILE:

09/02/92 RADIANT.WK3 DENNIS JONES #3105.000



ENEKGY USAGE (MBTU)

JAN

### RADIANT HEAT HEAT LOADS

			INTERNAL	WEEKDAY	WEEKEND	WEEKLY
	WEEKDAY	WEEKEND	PEAK	HOURLY	HOURLY	AVERAGE
HOUR	PROFILE	<b>PROFILE</b>	LOAD	LOAD	LOAD	HOURLY
1	0.05	0.05	375332	18767	18767	INTERNAL
2	0.05	0.05	375332	18767	18767	LOADS
3	0.05	0.05	375332	18767	18767	
4	0.05	0.05	375332	18767	18767	
5	0.05	0.05	375332	18767	18767	
6	0.05	0.05	375332	18767	18767	
7	0.05	0.05	375332	18767	18767	<u> </u>
8	0.8	0.05	375332	300266	18767	]
9	1	0.05	375332	375332	18767	
10	1	0.05	375332	375332	18767	]
11	1	0.05	375332	375332	18767	
12	0.8	0.05	375332	300266	18767	_
13	1	0.05	375332	375332	18767	]
14	1	0.05	375332	375332	18767	]
15	1	0.05	375332	375332	18767	]
16	0.8	0.05	375332	300266		
17	0.8	0.05	375332	300266		]
18	0.4	0.05	375332	150133	18767	
19	0.05	0.05	375332	18767	18767	
20	0.05	0.05	375332	18767		
21	0.05	0.05	375332	18767		
22	0.05	0.05	375332	18767	18767	]
23	0.05	0.05	375332	18767		
24	0.05	0.05	375332	18767	18767	
AVERAGE				160298	18767	119860

SEE COMPUTER SIMULATION OF BLDG 207 FOR PEAK LOAD AND LOAD PROFILE

BUILDING LOAD COEFICENT 0.471 Btu/sq.ft./hr/oF x 149300 sq.ft 70320 SEE COMPUTER SIMULATION OF BLDG 207 FOR BLDG HEAT LOSS COEF.

### **Energy Consumption Calculations**

The chief characteristic of radiant heating systems which results in energy savings is the reduction in room air temperatures and a corresponding reduction in envelope heat loss. Additional energy savings are also often the result of an increase in combustion efficiency over conventional heating equipment efficiencies. A simple means for determining heating loads is the variable degree day method [Ref. 8]. The Variable Base Degree Day method was selected due to its simplicity and its compatibility with the mathematical model. The Bin method was also considered, but was rejected since part-load efficiencies for radiant equipment were not available. The only advantage of the Bin method was its ability to consider part-load efficiencies.

Monthly values of degree days at a base temperature of 65°F (18°C) are tabulated for many locations all over the world [Ref. 5, 6]. The base 65°F (18°C) temperature may be corrected to other bases by the following formula [Ref. 4]:

$$DDm = Nm (t_b - t_{OSA} + C) , \qquad (12)$$

where

DDm = degree days at the new base temperature,

Nm = number of days in the month,

t = new base temperature,

tosa = average outside air temperature,

C = correction factor.

The correction factor (C) is given by:

$$C = 1.339(0.00387 DDa - 0.277 \times 10^{-6}DDa^{2})$$

$$x \exp - [(t_b - t_{OSA} + 20^{\circ}F) / 16.23]^2,$$
 (13)

where

DDa = annual base 65'F degree days.

Monthly energy consumption (L) for space heating is:

$$L = BLC \times DDm / E_{cc}, (14)$$

where

BLC = building loss coefficient,

 $E_{\infty}$  = combustion efficiency of a conventional system.

The BLC is the sum of the individual heat loss factors (component area divided by thermal resistance) for building components plus infiltration/ventilation loads. The following components are generally included:

- Walls
- Ceiling
- Windows
- Doors
- Floor perimeter
- Infiltration/ventilation.

Base temperature (t,) is calculated as follows:

$$t_b = t_a - Q_0/UA , \qquad (15)$$

where Q<sub>a</sub> is the energy generated by lights, equipment, occupants, and solar gains.

The heating load for the conventional heating system is then calculated using equation (14) in which degree days is based on the base temperature from equation (15). For conventionally heated buildings, the indoor air temperature  $(t_a)$  in equation (15) is equal to the thermostat setpoint.

### **Radiant Heat Evaluation**

The previous study used a computer model to iteratively solve equations (7) through (11) in the order presented. In order to make the model more efficient and to develop nomographs, it was necessary to develop a single equation for performance.

For any given application, equations (7) through (11) will have five unknowns:

ERF<sub>c</sub> = radiant flux from ceiling,

ERF<sub>F</sub> = radiant flux from floor,

t<sub>a</sub> = indoor air temperature,

t = floor temperature,

Q<sub>R</sub> = system energy input.

Solving the five equations simultaneously results in the following expression for indoor air temperature (t\_):

$$t_a = t_o - [M/(M+1)](t_o - t_{OSA} - Q_G/BLC)$$
, (16)

where

t, = desired operative temperature,

M = radiant factor,

tosa = outside air temperature,

Q<sub>g</sub> = internal generated hear from lights, people, and equipment,

BLC = building envelope heat loss factor.

The radiant factor (M) is given by:

$$M = \frac{E_{R}}{A_{F}(h_{r}+h_{c})} \begin{pmatrix} F_{C} + F_{F}h_{r} \\ \hline h_{t} \end{pmatrix} BLC$$

where

E<sub>R</sub> = radiant efficiency,

 $A_F$  = floor area,

h, = total heat transfer coefficient from floor to room,

F<sub>c</sub> = ceiling angle factor,

 $F_F$  = floor angle factor,

h, = radiative exchange coefficient of human body,

 $E_{cR}$  = combustion efficiency.

Once indoor air temperature  $(t_{\bullet})$  is calculated, the remaining unknowns may be calculated from the equations (7) through (10).

The heating load for the radiantly heated building is calculated in two parts; for the floor and for the rest of the building. The floor in a radiantly heated building is maintained at a temperature higher than inside air temperature and thus has a proportionally higher heat loss. For the floor, the base temperature of equation (15) is set at the monthly floor temperature predicted for the radiant system. Heating load of the floor is then the corrected degree days based on floor temperature times the floor loss component of BLC divided by the combustion efficiency.

For the non-floor heating load, the base temperature is calculated from the indoor air temperature predicted for the radiantly heated space. The heating load of the non-floor components is then the corrected degree days times the non-floor components of the

BLC divided by the combustion efficiency. The total radiant heating load is then the sum of floor and non-floor heating loads.

For further information, the following references may be useful.

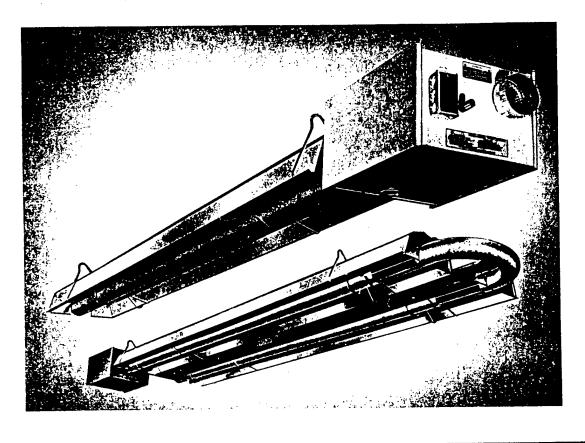
- American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Infrared Radiant Heating," <u>ASHRAE Handbook</u>, 1987 Systems and Applications Volume, Chapter 16, Atlanta, Georgia.
- American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "High-Intensity Infrared Heaters," <u>ASHRAE Handbook</u>, 1983 Equipment Volume, Chapter 30, Atlanta, Georgia.
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- 9. "Energy Prices and Discount Factors for Life-Cycle Cost Analysis," NBSIR 85-3273, -2 (Rev. 6/84).
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- 12. "Radiant Heat Investigation." USAREUR Contract No. DACA 90-86-D-0054, February 1988.

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1		fudy					X CODE A		CODEC		DPAWING NC	Ċ.		
Cose First Position* Heaser         Country         LAGOR         EQUIPMENT         MATERIAL         TOTAL         Unit Unit         Unit Unit         MAY         TOSA         Unit Unit         Unit Unit Unit         Unit Unit         Unit	LOCATION Ft. McPherson & Ft Gillem						OTHER THE				ESTIMATOR	RMG	CHECKED BY	
Contain Flaging Hosient   No. Of Link   May   Total   Unit   Link   Hosient   Link   Mass   Link   Hosient   Link   Mass   Link   Hosient   Link   Link   Hosient   Link   Link   Hosient   Link		6	ŧ		I ABOF	-		EQUPM	ENT	MATER	-¶AL	TOTAL	NIddiHS	වු
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Aŭ BOND 15%  108-TOTAL 15% SENCY  3ENCY  3ENCY 3	SUBTOTAL											\$10.00		
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BENCY 155%  SENCY	BANEIT	50,										8. E		
GENCY 15% 15% 15% 15% 15% 15% 15% 15% 15% 15%	COST SIR_TOTAL											\$1250		
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PROJECT Ft. McPherson & Ft. Gillem ESOS Study	S Study					X CODE A	CODEB	CODEC		DRAWING NO.	Ċ	SHT	
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7.00. 11.40. 4	8		0.474	0 42	\$20.88	\$196.69			\$6.10	\$122.00	\$318.69		
HOOF FLASHING, 4	8 8		77.0	0 43	#20 BB	£196.69			\$7.55	\$151.00	\$347.69		
FLUE ELBOW, 4"	8 8		7 7 6	7 70	8000	\$150.01			\$6.20	\$124.00	\$276.01		
FLUE TOP, 4*	88	5 4	1000	30.7	#20.00	\$6.305.76			\$1.54	\$3,080.00	\$9,385.76		
GAS PIPING, 1.	8	ב ל	2 6	400	8000	4256 R2			\$1235	\$247.00	\$503.82		
THERMOSTAI	8 8	5	0.00	5.7	90.00	4265 18			\$0.11	\$110.00	\$375.18		
THERMOSTAT WIRE, 2 COND	8	5	0.013	17:7	907	\$200.10			\$20.00	\$6,000,00	\$24,100.35		
B.ECTRIC SERVICE	900	MSF	2.85	822	\$21.17	\$18,100.35			3				
													`-
SUBTOTAL						\$30,630.86				\$30,468.00	7		
OVERHEAD BOND	15%					\$4,594.63				\$4,570.20	_		
POCET	10%					\$3,063.09				\$3,046.80	_		
radrii						\$38 288 57				\$38,085.00	-		1
COSI SUB-IOIAL	1007					\$5 743 29				\$5,712.75	\$11,456.04		
CONTINGENCY	4C1					#44 004 OF				\$43,797.75	\$87,829.60	_	
TOTAL													



### Cost-Saving, Low-Intensity Infrared Unitary Heaters



### Roberts-Gordon, Inc.

Energy Efficient Comfort.

# VANTAGE II Unitary Heaters Lower Fuel Costs and Raise Comfort Levels.

# **Demonstrated Savings**

Modern gas combustion technology combined with the principles of infrared energy enable VANTAGE II heaters to reduce fuel costs substantially while improving comfort conditions. Users report heating bills cut by up to 50% and more!

# Low Cost...Easy to Install and Maintain

The VANTAGE II models are low-cost, field-assembled infrared heaters that are easy to install and require only minimal maintenance. They are designed to provide years of economical operation and trouble-free service.

# Versatility

VANTAGE II heaters can be installed separately or in combination to fit any floor plan. Straight, L- and U-tube configurations are available. Tube lengths are offered from 10 through 60 feet. Ideal for large areas as well as hard-to-heat spaces!

# Reliability and Expertise

Roberts-Gordon pioneered low-intensity infrared heating systems in 1962 and manufactures the broadest line of low-intensity heating equipment in North America. Backed by a limited three-year warranty, each VANTAGE II unitary heater is built to uphold the well-established Roberts-Gordon standards of engineering excellence, efficiency and reliability.

# **Applications Include:**

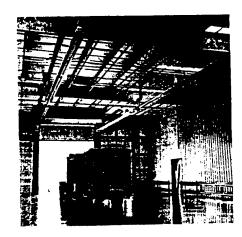
- Automotive Facilities
- Warehouses
- Manufacturing Facilities

Clean, quiet, draft-free Vantage radiant heat is ideal for this automotive service facility. Unlike forced-air unit heaters, Vantage does not spread dirt, grit or dust.

- Fire Stations
- Agricultural Buildings
- Recreational Facilities

Vantage unitary heaters are available in a variety of lengths, shapes and configurations to fit any floor plan. Two straight-tube models are shown above in a car dealership.

- Machine Shops
- Aircraft Hangars
- Vehicle Maintenance Buildings



Floors are kept warm by Vantage infrared energy and act as heat reservoirs to provide rapid heat recovery after bay doors are closed in this warehouse/ shipping area.



### Features:

Extensive use of corrosion-resistant materials.

- Weight-saving construction to ease installation.
- Forced draft design eliminates the need for a heat-siphoning draft hood.
- Quiet operation.
- 10 through 60 foot tube lengths.
- Three-year limited warranty on all components.
- A.G.A. design certified.

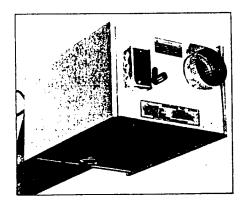
"The VANTAGE II heater utilizes design concepts and engineering principles proven by more than 25 years of infrared heating experience."

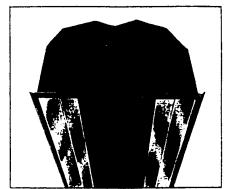
### **Burner Box:**

- 40,000; 60,000; 80,000; 100,000; 125,000 and 150,000 BTU/Hr. models available.
- Natural gas and L.P. models available.
- Moisture-resistant design.
- Stainless steel burner cup.
- Outside air adapter standard.
- Hot surface ignition.
- Three-try ignition module.
- Door interlock safety switch.
- All components easily accessed.
- Electrostatically applied paint.
- Durable spot welded construction.
- Mica flame observation window.
- Balanced air rotor.
- Stainless steel flex gas line and high pressure gas cock included.

# **Tube and Reflector:**

- 4" diameter 16 gauge tubing.
- Quick assembly couplings.
- Deep-dish aluminum reflectors maximize energy reflection, beaming virtually all of the radiant heat downward.
- Reflectors can be tilted 45° to direct heat where needed.
- Entire U-tube heater also can be tilted 45°.
- End caps included.
- · Nickel plated hangers.
- Chrome plated hardware.
- Flue connector included.
- 180° U-package (9" radius) option.
- 90° L-package option.
- Decorative grille option.
- Side reflector option.





# Architectural/Engineering Short Form Specifications VANTAGE II CTH2 SERIES

Gas-fired, vented, infrared heaters shall be furnished and installed in accordance wibuilding drawing(s) as described below.	
Heaters shall be VANTAGE II, model number CTH2, by Roberts-Gordon, Inc., Buffalo, New York.	BTU/Hr. as manufactured
Heaters shall be equipped with a direct sense silicon-carbide hot surface ignition cont device. Power supplied to each heater shall be 120V, 60Hz, 1\$\phi\$. Heater to be equip thermal overload motor protection, balanced air rotor, combustion air proving sa burnerhead, combustion chamber equipped with sight glass for visual inspection of intake collar standard. Radiant tube assembly to be 4" diameter, aluminized steel firs unit. (Or at customer option, all aluminized steel for entire tube length.) Reflector to be direct all radiant output below horizontal centerline of radiant tube. Heaters manufacturer's recommendations and ANSI Z-223.1 National Fuel Gas Code. Heaters without requiring heater modifications or adjustments on	fety pressure switch, stainless steel igniter element and burner flame. Air t 10 feet. Hot rolled steel remainder of pe of aluminum material and designed shall be vented in accordance with ters shall be so designed to operate as having a net heating value of

Heaters shall be Design Certified by the American Gas Association (A.G.A.). Supplier shall provide a manufacturer's written warranty covering all components for a period of three (3) years.

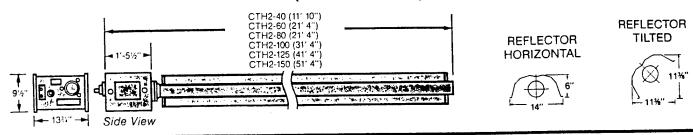


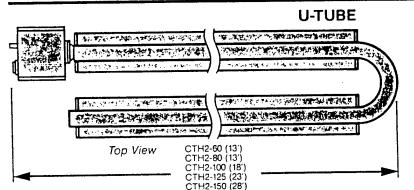
FLUE	CONNECTION	ELECTRICAL RATING	TUBE DIAMETER	IGNITION SYSTEM	MIN. GAS
4" (O.D.)	1/2" NPT	120VAC, 60Hz. 1.0 amp run 5.0 amp start	4''	Hot surface (Three-try)	Nat. 4.6" W.C. L.P. 11.0" W.C.

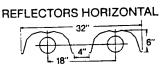
MODEL	BTU/Hr. (Natural Gas or L.P.)	SHIPPING WEIGHT
CTH2-40	40.000	95 lbs.
CTH2-60	60,000	130 lbs.
CTH2-80	80,000	130 lbs.

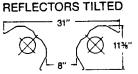
MODEL	BTU/Hr. A (Natural Gas L) or LP)	SHIPPING TANKE
CTH2-100	100,000	165 lbs.
CTH2-125	125,000	200 lbs.
CTH2-150	150,000	235 lbs.

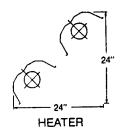
### **DIMENSIONS (Standard Models) STRAIGHT**











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### **CLEARANCES TO COMBUSTIBLES\***

The state of the	(31) (31) (31)	<b>1</b>	CTH2-4	, ;, ,	137	CTH2-6	0	47.1	CTH2-8	0 70	7	CTH2-10	20		CTH2-1	25		CTH2-1	50
Configuration -	Reflector	Тор	Below	Side	Тор	Below		Тор	Below	Side }	Тор	Below	Side	Тор	Below	Side	Top	Below	% Side
Straight 3 %	'Horizontal	4"	50"	22"	4"	60"	30"	4"	63"	33"	4"	68"	35"	4"	74"	41"	4"	77"	45"
Straight,	Tilted &	4"	45"	4"/42"	4"	54"	4"/50"	4"	60"	4"/56"	6"	68"	4"/60"	6"	72"	4"/65"	8"	78"	4"/70"
U-Tube 6	Horizontal		<u> </u>	<b> </b>	4"	60"	25"/30"	4"	66"	32"/33"	4"	73"	34"/35"	4"	76"	38"/41"	4"	81"	42"/45"
U-Tube Car			_	-	4"	54"	18"/50"	4"	60"	18"/56"	6"	68"	18"/60"	6"	72"	18"/66"	8"	78"	18"/70"

Configuration	Heater	Тор	Below	Side	Тор	Below	Side	Тор	Below	Side	Тор	Below	"Side	Тор	Below	Side	Тор	Below	Side
3 U-Tube	Tilted		_		4"	54"	4"/38"	4"	60"	4"/42"	4"	68"	4"/48"	4"	72"	57"	4"	78"	4"/62"

<sup>\*</sup>See installation manual for complete information.



# Roberts-Gordon, Inc.

Subsidiary of A.J. Industries, Inc.

P.O. Box 44 • Buffalo, NY 14240-0044 Phone: (716) 852-4400 • Fax: (716) 852-0854



CALL TOLL FREE: 1-800-828-7450 IN NEW YORK: 1-800-221-0955



ENERGY ( INSTALLATION PROJECT NO. ( FISCAL YEAR )	CONSERVATION & LOCATION: & TITLE: DACA L992 DISCRE	INVESTMENT I FT. GILLEM 21-91-C-0097 TE PORTION N	JMMARY PROGRAM (ECIP) REGION NOS. TENERGY SAV JAME: ECO-15 SI IFE 25 YEARS F	LCCID 4 CENSUS: INGS OPPORT EPARATE SWIT	1.062 3 UNITY SUP CHES FOR	VEY LIG
B. SIOH C. DESIG D. SALVA E. TOTAL	RUCTION COST N COST GE VALUE COST INVESTMENT (	1A + 1B + 10	c - 1D)		\$ 16 -\$	971. 184. 519. 0. 974.
2. ENERGY SA ANALYSIS	VINGS (+) / C DATE ANNUAL	OST (-) SAVINGS, UN	IT COST & DISC	COUNTED SAVI	NGS	
FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNT SAVINGS	red (5)
A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ 7.47 \$ .00 \$ .00 \$ 4.67 \$ .00	163. 0. 0. -18. 0.	\$ 1218. \$ 0. \$ 0. \$ -82. \$ 0.	15.61 21.66 26.51 23.77 16.06	190 -19	0. 0. 954.
			<b>\$</b> 1136.			
3. NON ENERG	Y SAVINGS(+)	/ COST(-)				
A. ANNUAL	RECURRING (+	·/-)		14.53	\$ 1	141.
(2) D	ISCOUNTED SAV	ING/COSI (3	,			
C. TOTAL	NON ENERGY DI	SCOUNTED SA	VINGS(+)/COST	(-)(3A2+3Bd4	1)\$ 16	579.
(1) 2	A TF 3D1 TS =	NERGY CALC ( = OR > 3C G	2F5 X .33) O TO ITEM 4			
	B IF 3D1 IS <	<pre>3C CALC = &gt; 1 GO T</pre>	SIR = (2F5+3)		75	
4. FIRST YEA	AR DOLLAR SAVI	INGS 2F3+3A+	(3B1D/(YRS EC	ONOMIC LIFE	)\$ 2	277.
5. TOTAL NET	DISCOUNTED S	SAVINGS (2F5	5+3C)		\$ 33	639.
6. DISCOUNTE (IF < 1 **** Project doe	PROJECT DOES	NOT QUALIFY	(SIR)=(5 / (Sinding; 4,5,6)			.y.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.21

# SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15 BUILDING 184, ROOM 6

### Given:

# of Fixtures = 2 fixture - from survey notes Fixture Type = 4x24-lamp fluorescent - from survey notes Watts / Fixture = 155 W / fixture - from manufacturer info Percent Lighting Savings = 19%- average for all bldgs Hours On / Year - from bldg occupancy = 3,393 hrs / yrGas Increase Factor = 5.4E-4 MBtu / kWh
Electric Savings Factor = 0.17 kWh / kWh - from computer simulation - from computer simulation Gas Cost = \$4.67 / MBtu - from utility rate analysis Electric Cost = \$0.0255 / kWh- from utility rate analysis Demand Cost = \$8.85 / kW - from utility rate analysis

### **Existing Lighting Demand:**

 $(2 \text{ fixtures})^*(155 \text{ W} / \text{fixture}) = 0.31 \text{ kW}$ 

### Peak Demand Savings:

$$(0.31 \text{ kW})^*(0.19) = 0.06 \text{ kW}$$

### **Annual Energy Savings:**

Electric:
Lighting:
(0.06 kW)\*(3,393 hrs / yr) = 200 kWh / yr
Cooling:
(200 kWh)\*(0.17 kWh / kWh) = 34 kWh / yr
Total:
200 + 34 kWh / yr = 234 kWh / yr

Gas:
(200 kWh /yr)\*(5.4E-4 MBtu / kWh) = 0.1 MBtu / yr

### **Annual Cost Savings:**

 $(234 \text{ kWh})^*(\$0.0255 / \text{kWh}) + (0.06 \text{ kW})^*(\$8.85 / \text{kW})^*(4 + .95 * 8) - (0.1 \text{ MBtu})^*(\$4.67 / \text{MBtu}) = \$12.08 / \text{yr}$ 

### **Estimated Construction Cost:**

\$65.11 / wall sensor - from engineer's cost estimate (\$65.11 / ea)\*(1 sensor) = \$65 \$65 + (\$65 \* .055 SIOH) + (\$65 \* .055 DESIGN) = \$72

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE: FILE: PRPARED BY:

CHECKED BY:

#3105.000 07/20/92 MLITSIR.WK3 CAMERAN DIBAI

> 23.77 UPWG 15.61 UPWE 14.53 UPW **FACTOR** DISCOUNT \$4.67 MBtu \$0.0255 kWh 25 YRS \$102.66 kW COST ENERGY INCREMENTAL ELECTRIC COST **ELECTRIC DEMAND CHARGE** NCREMENTAL GAS COST **ECONOMIC LIFE**

FSTIMATED 8760 HOURS OF LIGHTING PER YEAR	
	]

	SIMPLE	SIR PAYBACK	(YRS)	2.4 6.1	2.1 7.2	1.1 13.5	1.0 15.4	1.1	0.5 28.6					0.3 58.6	0.3 58.6	0.3 58.6	0.3 58.6	0.3 58.6	0.3 58.6	0.3 58.6	0.3 58.6	45,6
	CONST.	COST	(€)	\$436	\$3,349	\$3,465	\$22,822	\$30,072	\$2 417	\$17,634	\$29 154	900 1E4	\$53,134	\$29,154	\$29,154	\$29,154	\$29,154	\$29,154	\$29,154	\$29,154	\$29,154	9000
TOTAL	ANNUAL	SAVINGS	(\$)	\$72	\$466	\$257	\$1,482	\$2,277	685	\$575	8073	000	2543	\$498	\$498	\$498	\$498	\$498	\$498	\$498	\$498	-
ANNUAL	NON-ENERG	SAVINGS	(\$)	0\$	\$	80	<b>S</b>	<b>0\$</b>	00 00	00.00	00.00	90.00	\$0.00	\$0.00	\$0.00						\$0.00	0000
ANNUAL			<b>(%</b>	\$31	\$236	\$126	\$747	\$1,141	95.4	4004 4005	600	224	\$33	\$33	\$33	\$33	\$33	\$33	\$33	\$33	\$33	
ANNOAL	ENERGY	SAVINGS	(8)	\$41	\$230	\$131	\$735	\$1,136	6	926	0074	C044	\$465	\$465	\$465	\$465	\$465	\$465	\$465	\$465	\$465	
TOTAL	FNFRGY	SAVINGS	(MBtu)	5	30	15	95	145		n 8	53	66	59	69	5.0	59	65	65	65	59	59	
ANNI IAI	NAT GAS	SAVINGS	(MB#1)	0 581	(1 72)	(5.80)	(9.48)	(17.58)		(2.96)	(28.50)	(8.14)	(8.14)	(8.14)	(8 14)	(41.8)	(41.8)	(4) (6)	(8.14)	(8.14)	(8.14)	,
ANNITAL	FIECTBIC	SAVINGS	(KWH)	1 702 0	93164	6 1930	30.555.0	47,766.4		1,723	15,020	19,718	19,718	19 718	40 748	19,710	10,710	917.01	19,710	19,718	19.718	
ANIMITAL	DEMOND	SAVINGS	00 MAY	0 304	0.00	L.3	7 28	11:11		0.53	3.17	0.32	0.32	030	20.0	0.32	0.92	0.35	0.32	0.32	0.32	10:0
			0	103	25.5	212	5	TOTAL		400	207	202	909	507	002	000	203	510	510	212	213	7

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SUBTOTAL						\$5.23	6			\$40.00			
OVERHEAD, BOND	15%					\$0.79	6			\$6.00	£6.73		
PROFIT	10%					\$0.53	3			8.5			
COST SUB-TOTAL						<b>\$6.62</b>	2			\$50.00			
CONTINGENCY	15%					\$0.99	6			\$7.50			
						S7 81	_			\$57.50	\$65.11		_

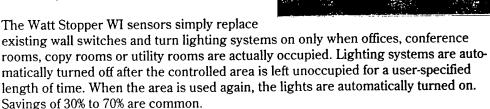
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Total   Countries   Countrie	LOCATION Ft. McPherson & Ft Gillem						OTHER				ESTIMATOR	-¥WG	CHECKED BY CE.	명
No. Ol unit   No. Ol unit			-					Mailos	FINE	MATTER	IAI	TOTAL	SHIPPING	ā
Molecular   Multi	INDIVIDITAL OFFICES: SINGLE LEVEL LIGHTING		٦		BS S					:		 	- E	Total
Units   Mees   Unit   Hts   Price   Cost   Price   Price   Cost   Price   Price   Cost   Price   Price   Cost	CONTROL FROM OCCUPANCY SENSORS	₽	Chit	Ì	Total	Chit		Chit		5 ;	1		<u> </u>	3
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1   EA   0.056   0.051   \$10.16   \$10.16   \$20.00   \$20	*W 1000A-ULI HASOINIC SENSON	+		20.0	0.95	521.17	\$20.11			\$25.00	\$25.00	\$45.11		1
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## ## ## ## ## ## ## ## ## ## ## ## ##	WIKEMOLD SURFACE METAL FACEWAY			0 0	1 0	604 47				\$10.00				
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TAL         \$219.74         \$55.85         \$65.85         \$1.38         \$65.85         \$2.19.74         \$65.85         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.19         \$2.10														
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TAL         \$219.74         \$55.85         \$55.85         \$55.85         \$55.85         \$55.85         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$65.89         \$69.81         \$69.81         \$69.81         \$69.81         \$69.81         \$69.81         \$69.28         \$69.28         \$69.28         \$60.28 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>														
SAD, BOND         15%         \$21.97         \$8.38           SAD, BOND         \$21.97         \$5.59           SUB-TOTAL         \$274.68         \$69.81         \$10.47           GENCY         15%         \$41.20         \$80.28         \$80.28	SIBTOTAL	-					\$219.74				\$55.85			_
SULPCINE         \$21.97         \$5.59           SUB-TOTAL         \$274.68         \$69.81         \$10.47           GENCY         \$41.20         \$10.47         \$80.28         \$80.28	SUBJECT DAID	1	k				\$32.96				\$8.38			
UB-TOTAL         \$274.68         \$69.81         \$69.81         \$69.81         \$69.81         \$69.81         \$69.81         \$69.81         \$60.47         \$10.47         \$80.28         \$80.	DESCRIPTION DOING	2 5	2 3				\$21.97				\$5.59			
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\$60.28 \$80.28	CONTINUENCY	15.	*	-			\$41.20				\$10.47			+
	TOTAL	2					\$315.88				\$80.28			



# **Passive Infrared Wall Switch**

- · Simply replaces existing light switches
- Large 1000 sq. ft. of coverage
- Built-in light level sensor
- Adjustable Sensitivity & Time Delay
- Advanced transformer/latching relay design
- Compatible with Electronic Ballasts
- Proven 30% to 70% savings
- Available in 24VDC and 24V Half Wave
- Three-year warranty; UL Listed

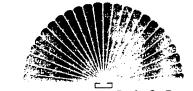


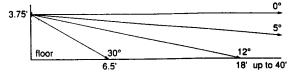
Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates. They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.





**System Information** 

Sensor Operation

Advanced Light-Level Sensing

Design

Applications and Economics

The Watt Stopper, Inc. Santa Clara, CA 95050 TEL: (408) 988-5331 FAX: (408) 988-5373 Plano, TX 75023 1-800-879-8585

# **WI Sensor Technical Information**

### WI Sensor Specifications

- Part of a completely integrated line of lighting control products
- Coverage: covers a 180° area 40 foot range with adjustment
- Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- Adjustable unit sensitivity
- Integrated light level sensor works from 5 to 400 footcandles
- Red LED display to indicate detection
- Advanced transformer/latching relay design for WI-120A & WI-277A
- Works with solid-state ballasts and PL type lamps
- No leakage current in off mode Patent Pending
- Small size 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- Voltage drop protection Patent Pending
- Integrated four level fresnel lens Patent Pending
- Three-year warranty; UL Listed
- Available in Tamper Proof Model, and in White or Ivory

### Ordering Information

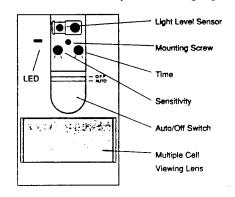
Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for	Two Gang Box		1
ASP-112	Switch Plate C	over-Dual Switch		1

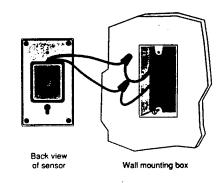
Notes: \*1 - Add a TP to Catalog No. for Tamper Proof, and add a W for White or I for Ivory

\*2 - Used with Watt Stopper Power Packs

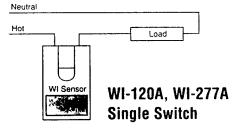
\*3 - For half-wave pulse, low-voltage lighting systems

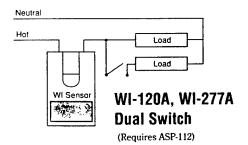
# Product Controls and Installation

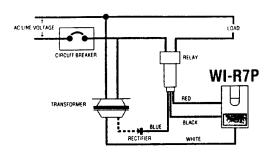


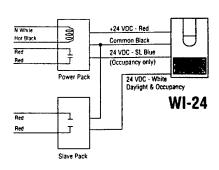


### **Circuit Schematics**





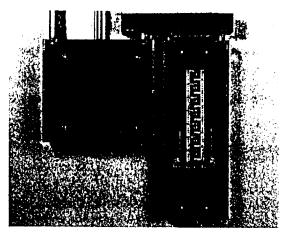




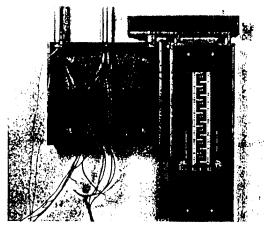
The Watt Stopper, Inc. Santa Clara, CA 95050 Pub. No. 0302

### TLC LAP Installation

### **Mount Tub**

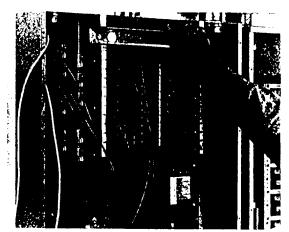


Mount the tub next to the lighting distribution panel.

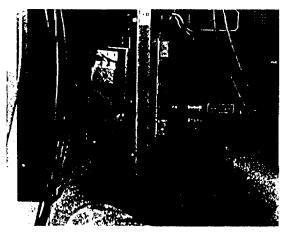


Run line voltage winng from cubuit breaker to tub and switched circuits from tub it areas

# Mount Interior Install Power Supply

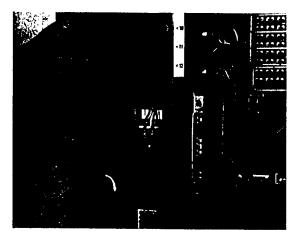


Slide the interior into the tub and secure.

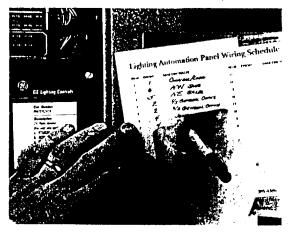


Mount the power supply to the interior and plug in.

# Connect Line Voltage Wiring



Connect line voltage wiring to the relays and power supply.



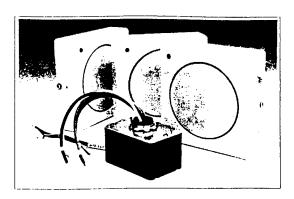
Install cover. Record all connections on the Wiring Schedule Card on the rear of the cover. Power up.

All lighting in the area is now under TLC relay control. Proceed to add direct switches and occupancy sensors.



# **Ultrasonic Sensors**

- Proven 30% to 60% savings; Turn lights on only when needed
- ◆ 500, 1000 and 2000 sq. ft. coverages available
- ◆ Adjustable sensitivity & time delay
- Fully-integrated product line
- UL Listed; Three-year warranty



### Complete Systems Integration

Operation

**Features** 

**Applications** 

**Economics** 

The Watt Stopper, Inc.

Santa Clara, CA 95050 TEL: (408) 988-5331 FAX: (408) 988-5373 Plano, TX 75023 1-800-879-8585 Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- ◆ Solid State, crystal-controlled (25 KHZ±.005)
- Omni-directional transmission (360° coverage)
- ◆ Temperature and humidity-resistant 25 KHZ Microphone Receivers
- ◆ Logic Key/ON bypass
- ◆ 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- ♦ Available in White or Ivory

# **Ultrasonic Sensor Technical**

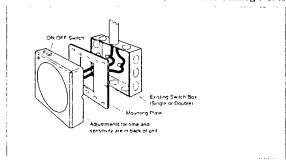
### **Ordering Information**

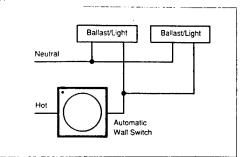
Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft 180°	-
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft 180°	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft 360°	1, 2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft 360°	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft 360°	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

- \*1 Used with Watt Stopper Power Packs.
- \*2 Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.

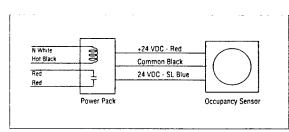
Note: Standard models are White, add an I to Catalog No. for Ivory.

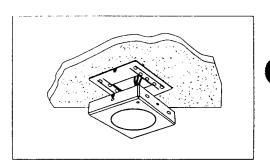
### Wall Switch Placement and Schematic

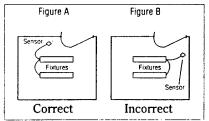




### Ceiling Sensor Placement and Schematic

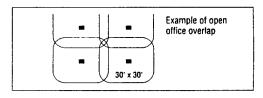




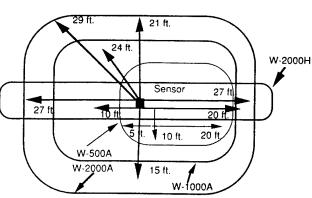


For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.

For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.



### Ceiling Sensor Coverage



For open office space the W-2000A is the most often used because of its true 360° coverage and capability to bounce off of partitions, walls, floors and other reflecting objects to sense motion. A typical layout for open office space is for the ultrasonic sensors to control the office area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is about 25' x 25' for the lighting fixtures and an overlap on the sensor coverage that picks up to 30' x 30'.

The Watt Stopper, Inc. Santa Clara, CA 95050 Pub. No. 0102

\*\*The W-2000H drawing is not drawn to scale. Coverage is 10' x 100' in a hallway, walls are necessary for this coverage pattern.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92

DATE:

G101LITE.WK3 FILE: PREPARED BY: JW

CHECKED BY: CEL

EXIT SIGNS:

70

**BUILDING NUMBER:** 

101

Sheet 1 of 5

600 to 2100 S-S 0 to 0 S-S Schedule #1 M-F 0 to Schedule #2 M-F 0 to

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of	Unocc. Lights
No.	Fixtures	Fixture Description	Survey	Yes/No	Sensor	Switches	On
218	17	4x2-4 lamp fluorescent	on	yes	no	2	no
220	12		on	yes	no	2	yes
222	1	4x2-4 lamp fluorescent	on	yes	по	1	yes
223	1	4x2-2 lamp fluorescent	on		no	1	yes
225	18		off	yes yes	no	4	по
227	10		on		no	1	по
228	16		on	yes	no	3	по
229		4x2-4 lamp fluorescent	on	yes	no	1	yes
	2	4x2-2 lamp fluorescent	off	yes	no	1	no
230				yes	no	1	по
232	1	4x2-4 lamp fluorescent	off	yes	no	1	no
236	4	4x2-4 lamp fluorescent	on	yes		1	
336	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
339	5	4x2-4 lamp fluorescent	оп	yes	по	1	по
341	2		on	yes	no		no
343	2		on	yes	no	1	no
342	4	4x2-4 lamp fluorescent	on	yes	yes		no
345	3	4x2-4 lamp fluorescent	on	no	yes	0	yes
201	64	4x2-4 lamp fluorescent	on	yes	no	12	по
204	3		on	yes	по	1	no
207	3	4x2-4 lamp fluorescent	on	yes	no	1	по
209	3	4x2-4 lamp fluorescent	on	yes	no	1	no
210	2	ļ	on	yes	по	1	yes
211	2		on	yes	no	1	yes
212	1	4x2-4 lamp fluorescent	on	no	по	0	yes
213	11	4x2-4 lamp fluorescent	on	yes	no	3	yes
214	14		on	yes	no	3	по
215	2	4x2-4 lamp fluorescent	on	по	no	0	уөз
216	4	4x2-4 lamp fluorescent	off	yes	yes	1	по
433	2	60 Watt Incandescent	off	yes	no	1	yes
301	1		off	yes	no	1	no
303	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
305	2		off	yes	yes	1	no
307	16		on	yes	no	2	no
311	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
312	3	4x2-4 lamp fluorescent	on	yes	по	1	по
316	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
317	5	4x2-4 lamp fluorescent	on	yes	по	1	no
320	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
322	1	4x2-4 lamp fluorescent	off	yes	no	1	по
324	1	8'-2 lamp fluorescent	off	no	по	0	по
328	1	8'-2 lamp fluorescent	off	no	no	0	no
330	68	4x2-4 lamp fluorescent	on	yes	по	17	no
332	2		on	yes	yes	1	yes
334	1	4x2-2 lamp fluorescent	on	yes	по	1	по
401	25	4x2-4 lamp fluorescent	on	yes	по	6	no
403	2		on	yes	no	1	yes
405	3		off	yes	yes	1	по

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr -92

FILE: G101LI

G101LITE.WK3 IY: JW

PREPARED BY: CHECKED BY:

CEL

### **BUILDING NUMBER:**

101

Sheet 2 of 5

Schedule #1	M-F	600 to	2100	s-s	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

Room	# of	Fixture Description	On/Off During	Switch	Good For Occup.	No. of	Unocc. Lights
No.	Lights	Talle bookingson	Survey	Yes/No	Sensor	Switchee	On
407	1	75 Watt Incandescent	off	yes	по	1	ПО
409	7	<del>                                     </del>	on	yes	по	1	по
411	5	2x2-2 U-Bulb fluorescent	on	yes	no	2	по
413	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
414	4		off	<del>                                     </del>	yes	1	no
416		<u> </u>	off	yes		1	no
419	3	4x2-4 lamp fluorescent		yes	yes	1	no
	2	60 Watt Incandescent	off	yes	no		
422	3		on	yes	no	1	yes
423	2		off	no	yes	0	по
425	1		off	yes	no	1	no
427	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
429	47		on	yes	no	12	no
252	6		оп	yes	no	3	yes
253	1		off	yes	no	1	no
254	1 1		off	yes	по	1	no
233	2		off	yes	yes	1	no
234	9	1	on	yes	no	2	no
235	3		on	yes	no	1	no
237	16		on	yes	no	2	no
238	4		on	yes	no	1	yes
239	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
240	1	4x2-4 lamp fluorescent	on	yes	по	1	yes
241	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	по
242	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
243	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
244	1	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
245	1	60 Watt Incandescent	off	yes	по	1	no
246	3	4x2-4 lamp fluorescent	on	yes	no	1	по
247	3	4x2-4 lamp fluorescent	on	yes	no	1	no
248	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
249	3	† - · · · · · · · · · · · · · · · · · ·	оп	yes	no	1	no
250	8		on	yes	no	2	no
251	5	· · · · · · · · · · · · · · · · · · ·	on	yes	по	1	no
333	9	<u> </u>	on	yes	no	3	по
335	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
337	5	4x2-4 lamp fluorescent	on	yes	no	1	по
338	2		on	yes	yes	1	no
340	3	<u> </u>	on	yes	no	1	yes
344	2		on	no	no	0	yes
200	5	<del> </del>	on	yes	no	1	no
202	3		on	yes	yes	1	yes
203	3	· · · · · · · · · · · · · · · · · · ·	on	yes	yes	1	yes
205	3	<del>  </del>	on	yes	yes	1	yes
206	5		on	yes	yes	1	no
217	2	<del></del>	off	yes	yes	1	по
219		4x2-4 lamp fluorescent	on	- 1	no	8	no
219	1		off	yes	по	1	no

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

G101LITE.WK3

PREPARED BY: CHECKED BY:

CEL

Sheet 3 of 5

**BUILDING NUMBER:** 

101

			On/Off		Good For		Unoca.	
Room	# of	Fixture Description	During	Switch	Occup.	No. of	Lights	
Na.	Fixtures	the season for the season of the	Survey	Yes/No	Sensor	Switches	On	
224	4	4x2-4 lamp fluorescent	on		no	1	no	
226	8	4x2-4 lamp fluorescent	on	yes	no	2	по	
231	7	4x2-4 lamp fluorescent	on	yes	по	2	по	
300	5	4x2-4 lamp fluorescent	on	yes	по	2	no	
302	6	4x2-4 lamp fluorescent	on	yes	по	1	no	
304	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes	
306	9	4x2-4 lamp fluorescent	on	yes	no	2	no	
307	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes	
308	98	·	on	yes	no	8	no	
310	2	4x2-4 lamp fluorescent	on	yes	yes	1	по	
314	10	4x2-4 lamp fluorescent	on	yes	по	2	no	
313	6	4x2-4 lamp fluorescent	оп	yes	yes	1	yes	
318	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes	
321	1	4x2-4 lamp fluorescent	on	yes	no	1	yes	
323	85	<del></del>	on	yes	по	10	no	
325	3	+ - <del></del>	off	yes	yes	1	no	
326	2		on	yes	yes	1	yes	
327	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes	
329	2		on	yes	yes	1	по	
331	4		on	yes	yes	1	по	
400	6		on	yes	no	2	по	
402	10		on	yes	по	2	по	
406	2		off	yes	yes	1	no	
404	2	+	on	yes	yes	1	no	
408	2		off	yes	no	1	no	
408	1	+	off	yes	no	1	no	
410	8	+	on	yes	no	1	no	
412	48		оп	yes	no	5	no	
420	4		on	yes	yes	1	yes	
421	3		on	yes	по	1	yes	
424	1		off	no	yes	0	no	
426	5		on	yes	no	1	no	
428	8		off	yes	yes	1	no	
428	3	<del>                                     </del>	off	yes	yes	1	no	
430	4		on	yes	yes	1	по	
430	3	<del></del>	on	yes	no	1	no	
431	3		on	yes	no	1	по	
39	1		on	yes	yes	1	yes	
25	1		on	yes	yes	1	yes	
24	18		on	yes	no	7	no	
26	6		on	yes	yes	1	no	
	8	<del></del>	on	yes	yes	1	no	
23			on	yes	no	1	no	
22 46	4		on	yes	yes	1	no	
			on	yes	yes	1	yes	
6A 75			on	yes	по	1	no	
75	8	3 4x2-4 lamp fluorescent	on	yes	по	1	no	

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION: FORT GILLEM

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: CHECKED BY:

JW

CEL

**BUILDING NUMBER:** 

101

Sheet 4 of 5

Schedule #1	M-F	600 to	2100	s-s	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

			On/Off	<u> </u>	Good For Occup.	No. of	Unoca. Ughta
Room	# of	Fixture Description	During	Switch	Sensor	Switches	Ön
No.	Lights		Survey	Yes/No		1	по
74A	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
73A	1	4x2-4 lamp fluorescent	off	yes	yes	1	
73	10	4x2-4 lamp fluorescent	on	yes	по		no
72	4	4x2-4 lamp fluorescent	off	yes	no	1	no
71	12	4x2-4 lamp fluorescent	on	yes	no	1	no
HALL-1	8	4x2-4 lamp fluorescent	on	yes	no	2	no
67	2	8'-2 lamp fluorescent	off	yes	по	1	no
70	2	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	yes	1	по
61	6	4x2-4 lamp fluorescent	on	yes	по	2	no
68	1	l	on	yes	no	1	no
59	1	150 Watt Incandescent	off	yes	no	1	no
59	2	4x2-2 lamp fluorescent	off	yes	по	1	no
60	2		off	yes	no	1	по
21	20		on	yes	no	2	no
58	6	4x2-4 lamp fluorescent	on	yes	no	1	no
57A	1	4x2-4 lamp fluorescent	off	yes	по	1	no
57	1	4x2-2 lamp fluorescent	off	yes	по	1	no
56	2	4x2-4 lamp fluorescent	off	yes	no	1	no
54	3	4x2-4 lamp fluorescent	on	yes	no	1	no
55	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
53	4		on	yes	yes	1 1	no
53A	4		on	yes	yes	1 1	no
53B	3		on	yes	yes	1	yes
51	2		on	yes	no	1	yes
52	1	4x2-4 lamp fluorescent	on	no	yes	0	no
50	3		on	no	yes	0	yes
49	3		on	yes	по	1	уев
48	12		on	yes	no	2	yes
47	6		off	yes	yes	1	по
45	2		off	yes	yes	1	по
45	2	4x2-2 lamp fluorescent	off	yes	yes	1 1	no
44	1	150 Watt Incandescent	on	yes	no	1	уев
43	1	150 Watt Incandescent	on	yes	no	1	yes
34	4		on	yes	yes	1	no
71	12		on	yes	no	1	no
68	1		on	yes	yes	1	yes
61	8		оп	yes	no	2	
60	2		off	yes	yes	1	
59	1		on	yes	yes	1	no
59	2		on	yes	yes	1	no
21	20		on	yes	no	1	no
21	10		off	yes	по	1	ПО
40	2		оп	yes	yes	1	yes
41	1		on	yes	yes	1 1	yes
27	12	Single lamp fluorescent	on	yes	по	1	yes
27A	2	4x2-2 lamp fluorescent	on	yes	no	1	no

PROJECT: FORT MoPHERSON & FORT GILLEM EEAP STUDY

LOCATION: FORT GILLEM

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

G101LITE.WK3

PREPARED BY: CHECKED BY: JW

**BUILDING NUMBER:** 

101

Sheet 5 of 5

Schedule #1	M-F	600 to	2100	s-s	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

				On/Off		Good For		Unoco.
Roo	m	#of	Fixture Description	During	Switch	Occup.	No. of	Lights
Na		Lights		Survey	Yes/No	Sensor	Switches	On
,,,,	28	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
	8	8	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
2A	•	4	4x2-4 lamp fluorescent	on	по	yes	0	yes
2A 2C		4	4x2-4 lamp fluorescent	on	no	yes	0	yes
20 2B		8	4x2-4 lamp fluorescent	on	no	yes	0	yes
<u> 20</u>	<u> </u>	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
5B		2	4x2-4 lamp fluorescent	оп	yes	yes	1	по
58	6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
	ъ	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
3A		1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
3B			2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
	19	3	12V-75W HALOGEN	off	yes	по	1	по
	13	52		off	yes	по	1	no
	14	3		off	yes	no	1	no
14A		11	4x2-4 lamp fluorescent	on	yes	no	1	yes
	20	1				yes	1	yes
	16	1		on	yes	yes	1	yes
	15	2	4x2-4 lamp fluorescent	on		no	1	no
14B		2		off	yes	yes	0	yes
65A		8		off	no	no	0	ves
65B		6		on	no		1	no
65C		8		off	no	no	1	no
65D		12		on	yes	no	1	no
	76	1		off	yes	no	<del>                                     </del>	Ves
	86	3	4x2-2 lamp fluorescent	on	yes	yes	+	yes
88A		1	4x2-4 lamp fluorescent	on	yes	yes		<del></del>
	88	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
	77	8	4x2-4 lamp fluorescent	on	yes	yes	1	
	85	1	<del></del>	off	yes	yes		<del></del>
	88	1		on	yes	yes	1	<del></del>
}- <del></del>	87	- <del></del>		on	yes	yes	1	
	87	2		on	yes	yes	1	
<del></del>	78			off	yes	yes	2	
<del></del>	79	- 2		on	по	yes	C	
ļ	$-\frac{79}{80}$		5 4x2-4 lamp fluorescent	on	yes	yes	1	
	<u>80</u> 81		1 4x2-4 lamp fluorescent	off	yes	yes	1	
	82			off	yes	yes		l no
L				off	yes	yes		по
	84_		4x2 4 lamp fluorescent	off	yes	yes		no
L	83	{	3 4x2-4 lamp fluorescent	UII	y 93	, ,,,,		

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**BUILDING NUMBER:** 

101

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: JW CHECKED BY: CEL

Sheet 1 of 5

% Unnoc. lights:	19%	
Gas Increase Factor	3.60E-04	MBtu/kWh
Cooling Factor (Energy)	1.16	-
	~	

	Cost of Switch											
Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Sultable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Celling Sensor Cost
218	2.64	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	. NO	\$0.00
220	2.52	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
222	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
223	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
225	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
227	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
228	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
229	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
230	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
232	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
236	0.62	3915	0.00	0	0.000	0	ō	\$0.00	NO	\$0.00		\$0.0
336	0.47	3915	0.00	Ö	0.000	0	ō	\$0.00	NO	\$0.00	NO	\$0.0
339	0.78	3915	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00		\$0.0
341	0.70	3915	0.00	0	0.000	ō	0	\$0.00	NO	\$0.00		\$0.0
343	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
342	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00		\$372.0
345	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.0
201	9.92	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00		\$0.0
204	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
207	0.47	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00		\$0.0
209	0.47	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00		\$0.0
210	0.18	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00		\$0.0
211	0.31	3915	0.00	0	<del></del>	0		\$0.00	NO	\$0.00		\$0.0
212	0.16	3915	0.00	40	0.015	47	1	\$396.17	NO	\$0.00		\$0.0
213	1.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.0
214	2.17	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
215	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00		\$0.0
216	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
433	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
301	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
303	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.0
305	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.0
307	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
311	0.16	3915	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.0
312	0.47	3915	0.00	0		0	0	\$0.00	NO	\$0.00	NO NO	\$0.0
316	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
317	0.78	3915	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.0
320	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.0
322	0.16	3915	0.00	0	+	0		\$0.00	NO	\$0.00		\$0.0
324	0.21	3915	0.00	55		63		\$396.17	NO	\$0.00		\$0.0
328	0.21	3915	0.00	55		63		<del></del>		\$0.00		\$0.0
330	10.54	3915	0.00	30		0		\$0.00		\$0.00		\$0.
332	0.31	3915	0.06	231	0.083	267		\$0.00		\$65.11		\$0.
334	0.09	3915	0.00	0	+	0		\$0.00		\$0.00		\$0.
401	3.88	3915	0.00	0	<del></del>	0		\$0.00		\$0.00		\$0.
			0.00	0	<del> </del>	0	+	\$0.00	<del></del>	\$0.00		\$0.
403	0.31	3915					<del></del>	\$0.00		\$65.11		\$0.
405	0.47	3915	0.09	346 2607.841	0.125	401	- 0	\$0.00	TES	\$455.77		+ +0.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY



CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

101

EMC PROJECT: #3105.000 DATE: 22-Apr-92

G101LITE.WK3 FILE:

PREPARED BY: CHECKED BY:

CEL

Sheet 2 of 5

### **BUILDING NUMBER:**

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

					# A:10		No. of	New	Suitable	f Switches Wall	Sultable	Celling
. 1	Total		Lighting	Lighting	Total Gas	Total kWh	New	Switches	for Wall	Sensor	for Ceiling	Sensor
Room	kW/Month	Hours 'On'	kW/Month	kWh	Increase	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
No.	Lighting	Per Year	Saved	Saved/Yr 0	(MBtu)/yr	O O	0	\$0.00	NO	\$0.00	NO	\$0.00
407	0.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
409	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
411	0.46	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
413	0.31	3915	0.00	·		535	0	\$0.00	NO	\$0.00	YES	\$372.00
414	0.62	3915	0.12	461	0.166	401	0	\$0.00	YES	\$65.11	NO	\$0.0
416	0.47	3915	0.09	346	0.125	0	0	\$0.00	NO	\$0.00	NO	\$0.0
419	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
422	0.47	3915	0.00	0	0.000		1	\$396.17	YES	\$65.11	NO	\$0.0
423	0.42	3915	0.08	109	0.039	127	0	\$0.00	NO	\$0.00	NO	\$0.0
425	0.21	3915	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.0
427	0.31	3915	0.06	231	0.083	267	0	\$0.00	NO	\$0.00	NO	\$0.0
429	7.29	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
252	0.93	3915	0.00	0		0	0	\$0.00	NO	\$0.00	NO	\$0.0
253	0.09	3915	0.00	0	0.000			\$0.00	NO	\$0.00	NO	\$0.0
254	0.06	3915	0.00	0	0.000		0	\$0.00	YES	\$65.11	NO	\$0.0
233	0.31	3915	0.06	231	0.083	267 0	<u> </u>	\$0.00	NO	\$0.00	NO	\$0.0
234	1.40	3915	0.00	0				\$0.00	NO	\$0.00	NO	\$0.0
235	0.47	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$0.0
237	2.48	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$0.0
238	0.62	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$0.0
239	0.78	3915		0		0		\$0.00	NO	\$0.00	NO	\$0.0
240	0.16	3915	0.00	0				\$0.00	NO	\$0.00	NO	\$0.0
241	0.09	3915	0.00	0				\$0.00	NO	\$0.00	NO	\$0.0
242	0.16	3915		1				\$0.00	NO	\$0.00	NO	\$0.0
243	0.31	3915		0				\$0.00	NO	\$0.00	NO	\$0.0
244	0.09	3915	0.00	0				\$0.00	NO	\$0.00	NO	\$0.0
245		3915		0		0				\$0.00		\$0.0
246		3915	0.00	0		- 0			NO	\$0.00	NO	\$0.0
247		3915		0					NO	\$0.00		\$0.0
248		3915		0				<u> </u>		\$0.00		\$0.0
249		3915		0						\$0.00		\$0.0
250		3915								\$0.00		\$0.0
251										\$0.00		\$0.0
333						- (				\$0.00		\$0.0
335						- (				\$0.00		\$0.0
337						26				\$65.11		\$0.
338		3915					0 0			\$0.00		\$0.
340					0.000	9:				\$0.00		\$0.
344										\$0.00		\$0.
200					0.000					\$65.11		\$0.
202			0.09			40				\$65.11		\$0.
203						40				\$65.11		\$0.
205						40		<u> </u>		\$0.00		\$372
206						66				\$65.11		\$0
217	0.31					26				\$0.00		\$0.
219					0.000		0 0			\$0.00		\$0.
221		391	5 0.00	3533.40	0.000	1	0 (	\$0.00	NO NO	\$585.99		+ + + + + + + + + + + + + + + + + + + +

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**BUILDING NUMBER:** 

101

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: CHECKED BY: JW CEL

Sheet 3 of 5

% Unnoc. lights:	19%	_
Gas Increase Factor	3.60E-04	MBtu/kWh
Cooling Factor (Energy)	1.16	-

							Cost of Switches					and the second
Roam No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Well Sensor Cost	Suitable for Calling Sensor	Celling Sensor Cost
224	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
226	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
231	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
300	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NÖ	\$0.00
302	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
304	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
306	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
307	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
308	15.19	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
310	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
314	1.55	3915	0.00	0	0.000	0	Ō	\$0.00	NO	\$0.00	NO	\$372.00
313	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
318	0.31	3915	0.06	231	0.083	267	ō	\$0.00	YES	\$65.11	NO	\$0.00
321	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
323	13.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
325	0.47	3915	0.09	346	0.125	401	ō	\$0.00	YES	\$65.11	NO	\$0.00
326	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
327	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
329	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
331	0.62	3915	0.12	461	0.166	535	Ö	\$0.00	NO	\$0.00	YES	\$0.00
400	1.26	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
402	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
406	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
404	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
408	0.42	3915	0.00	250	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
408	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$372.00
410	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
412	7.44	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
420	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00		\$0.00
421	0.27	3915	0.00	70	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
424	0.20	3915	0.04	52	0.019	60	1	\$0.00	YES	\$65.11	NO	\$0.00
426	0.78	3915	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00		\$0.00
428	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00		\$0.00
428	0.28	3915	0.24	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
430	0.62	3915	0.03	461	0.166	535	0	\$0.00	NO	\$0.00		\$0.00
431	0.02	3915	0.00	0	0.000	333	0	\$0.00	NO	\$0.00		\$0.00
432	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
39	0.27	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
25	0.15	3915	0.03	115	0.040	134	0	\$0.00	YES	\$65.11	NO	\$0.00
24	2.79	3915	0.03	0	0.042	134	0	\$0.00	NO	\$0.00		\$0.00
26	0.93	3915		692	0.000	802	0	\$0.00	NO	\$0.00		\$0.00
			0.18									\$0.00
23	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00		
22	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
46	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
16A	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
74	1.24	3915	0.00	7991.855	0.000	0	0	\$0.00	NO	\$0.00 \$976.65		\$0.00

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY



CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**BUILDING NUMBER:** 101

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3 PREPARED BY: JW CHECKED BY:

CEL

Sheet 4 of 5

% Unnoc. lights:	19%
Gas Increase Factor	3.60E-04 MBtu/kWh
Cooling Factor (Energy)	1.16

								أأنبت ويوسب		Switches	6.0	O-m-
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Well	Suitable	Celling
Roam	kW/Month	Houre 'On'	kW/Month	kWh	Increase	Total kWh	New	Switches	for Wall	Sensor	for Cailing	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
4A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.0
3A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.0
73	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
72	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
71	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
ALL-1	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
67	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
70	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
69	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
61	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
68	0.21	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
59	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
59	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
60	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
21	3.10	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.0
58	0.93	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
	0.16	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
57	0.09	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
56	0.31	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
54	0.47	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
55	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.6
53	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.
3A	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.0
53B	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.0
51	0.31	3915	0.00	0	0.000	0		\$0.00	NO	\$0.00	NO	\$0.0
52	0.16	3915	0.03	40	0.015	47		\$396.17	YES	\$65.11	NO	\$0.0
50	0.47	3915	0.09	121	0.044	140		\$396.17	YES	\$65.11	NO	\$0.0
49	0.47	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$0.0 \$0.0
48	1.86	3915	0.00	0		0		\$0.00	NO	\$0.00	NO	\$372.
47	0.93	3915	0.18	692		802		\$0.00	NO	\$0.00	YES NO	\$0.0
45	0.42	3915	0.08	312		362			YES	\$65.11		\$0.
45	0.18	3915	0.03	132		154		\$0.00	YES	\$65.11	NO NO	\$0.
44	0.15	3915	0.00	0		0		\$0.00		\$0.00	NO	\$0.
43	0.15	3915		0		0		\$0.00		\$0.00	YES	\$372.
34	0.62	3915		461	0.166	535		\$0.00		\$0.00		\$0.
71	1.86	3915		0		. 0		\$0.00		\$0.00	NO	\$0.
68	0.21	3915		156		181		\$0.00		\$65.11		\$0.
61	0.71	3915		0		0		\$0.00		\$0.00		\$0.
60		3915		231	0.083	267				\$65.11		\$0. \$0.
59		3915		112		129		\$0.00		\$65.11	NO	
59				132	0.048	154		\$0.00		\$65.11		\$0.
21		<del>+</del>		0		C				\$0.00		\$0
21			0.00	0	0.000	C				\$0.00		\$0.
40	· · · · · · · ·				0.021	69				\$65.11		\$0
41				+	0.042	134	0			\$65.11		\$0.
27					0.000	C	) 0	\$0.00	NO	\$0.00		\$0
27A	0.18				0.000	C	0	\$0.00	NO	\$0.00		\$0.
	1	1	1	4755.218						\$976.65	<u> </u>	1

101

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

## **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92 DATE:

G101LITE.WK3 FILE: PREPARED BY:

CHECKED BY: CEL

Sheet 5 of 5

# **BUILDING NUMBER:**

% Unnoc. lights:

3.60E-04 MBtu/kWh Gas Increase Factor 1.16 Cooling Factor (Energy)

							agali ili ila	un Paul d'air	Cost of	Switches		
Room	Total kW/Month	Hours 'On'	Lighting kW/Month	Lighting kWh	Total Gas increase	Total kWhi Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Celling Sensor	Ceiling Sensor Cost
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/y	Saved/11	OWITCHES	\$0.00	NO	\$0.00	NO	\$0.00
28	0.27	3915	0.00	0	0.000	- 0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.74	3915	0.00	0	0.000	187	1	\$396.17	NO	\$0.00	YES	\$372.00
2A	0.62	3915	0.12	161	0.058			\$396.17	NO	\$0.00	YES	\$372.00
2C	0.62	3915	0.12	161	0.058	187	1		NO	\$0.00	YES	\$372.00
2B	1.24	3915	0.24	322	0.116	374	2	\$792.34	YES	<b>\$65.11</b>	NO	\$0.00
5A	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
5B	0.31	3915	0.06	231	0.083	267	0	\$0.00	NO	\$0.00	YES	\$372.0
6	0.62	3915	0.12	461	0.166	535	0	\$0.00		\$0.00	YES	\$372.0
3A	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$65.11	NO	\$0.0
3B	0.16	3915	0.03	115	0.042	134		\$0.00	YES		NO	\$0.0
19	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11		\$0.0
13	3.90	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
14	0.63	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
14A	0.16	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
20	0.09	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0
16	0.09	3915	0.02	66		77		\$0.00	YES	\$65.11		\$0.0
15	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11		
14B	0.31	3915	0.00	0		0		\$0.00	NO	\$0.00		\$0.0 \$372.0
65A	1.24	3915	0.24	322		374		\$792.34	NO	\$0.00		\$372.0
65B	0.93	3915	0.00	0	0.000	0		\$0.00		\$0.00		\$0.0
65C	1.24	3915	0.00	322	0.116	374				\$0.00		
65D	1.86	3915	0.00	0	0.000	0	0			\$0.00		\$0.0
76	0.16	3915	0.00	0	0.000	0	0			\$0.00		\$0.0
86	0.27	3915	0.05	199	0.071	230	0			\$65.11		\$0.0
88A	0.16	3915		115	0.042	134	. 0			\$65.11		\$0.0
88	0.18	3915			0.000	C	0	\$0.00		\$0.00		\$0.0
77	1.24	3915			0.332	1070	0	\$0.00		\$0.00		\$372.0
85	0.09	3915				77	0	\$0.00		\$65.11		\$0.0
88	0.21	3915			0.056	181	0	\$0.00		\$65.11		\$0.0
87	0.09	3915				79	0	\$0.00		\$65.11		\$0.0
87	0.18	3915				154	0	\$0.00		<b>\$65.11</b>		\$0.0
78	0.62	3915				535		\$0.00		\$0.00		\$372.0
79	0.31	3915				93	3 1	\$396.17		\$65.11		\$0.0
80	0.78	3915				669				\$0.00		\$372.
81	0.16	3915				134	1 0			\$65.11		\$0.0
82	0.16	3915				134	, C	\$0.00		\$65.11		\$0.
84	0.16	3915				134	1 0	\$0.00		\$65.1		\$0.
83	1.24	3915		1		1070				\$0.00		\$372.
Total	211.910		7.2751			30555	10	\$7,131.06		\$4,036.82	2	\$9,300.0

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK EMC PROJECT: #3105.000 DATE: 21-Apr-92

41E: 21-M

103LITE.WK3

PREPARED BY: CHECKED BY:

JW CEL

EXIT SIGNS:

FILE:

q

**BUILDING NUMBER:** 

103

Sheet 1 of 1

Schedule #1	M-F	600 to	1900 S-S	600 to	1900
Schedule #2	M-F	0 to	2400 S-S	0 to	2400

Floom No.	# of Fixtures	Fixture Description	On/Off Duting Survey	Switch Yee/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
2	4	4x2-2 lamp fluorescent	off	yes	no	2	по
3	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
4	1	4x2-2 lamp fluorescent	off	yes	no	1	по
5A	1	150 Watt Incandescent	off	yes	yes	1	по
5B	1	150 Watt Incandescent	off	yes	no	1	по
6	2	4x2-4 lamp fluorescent	off	yes	yes	1	по
7	1	150 Watt Incandescent	on	yes	no	1	yes
8	5		оп	yes	по	4	yes
9	5		off	yes	no	2	no
10	1	120 Watt Incandescent	on	yes	по	1	no
10	1	4x2-2 lamp fluorescent	оп	yes	no	1	no
12	2	4x2-2 lamp fluorescent	off	yes	по	1	no
13	1	4x2-2 lamp fluorescent	off	yes	по	1	yes
14	1	8'-2 lamp fluorescent	оп	yes	yes	1	yes
15	20		on	yes	по	3	no
15	4	8'-2 lamp fluorescent	on	yes	no	2	yes
16	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
17	3		on	yes	yes	1	yes
18	1	75 Watt Incandescent	on	yes	no	1	yes
19	2		on	yes	yes	1	yes
20	4	4x2-2 lamp fluorescent	оп	yes	no	1	no
21	1	75 Watt Incandescent	off	yes	no	1	yes

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 21-Apr-92

FILE: 103LITE.WK3

PREPARED BY:

JW CEL

Sheet 1 of 1

CHECKED BY:

**BUILDING NUMBER:** 

103

% Unnoc. lights: 19%
Gas Increase Factor 4.00E-04 MBtu/kWh

Cooling Factor (Energy) 1.18

						[		Cost of Switches					
Acom No.	Total kW/Month Lighting	Hours *On* Per Year	Lighting kW/Month Sayed	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yi		No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Well Serisor Cost	Buttable for Celling Sensor	Gelling Sensor Cost	
1	0.16	4745	0.03	140	0.056	165	0	\$0.00	YES	\$65.11	NO	\$0.00	
2	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
3	0.18	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
4	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
5A	0.15	4745	0.03	135	0.054	160	0	\$0.00	YES	\$65.11	NO	\$0.00	
5B	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
6	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00	
7	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
8	1.05	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
9	0.45	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
10	0.12	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
10	0.09	4745	0.00	0	0.000	0	Ö	\$0.00	NO	\$0.00	NO	\$0.00	
12	0.18	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
13	0.09	4745	0.00	Ō	0.000	Ō	0	\$0.00	NO	\$0.00	NO	\$0.00	
14	0.21	4745	0.04	189	0.076	223	0	\$0.00	YES	\$65.11	NO	\$0.00	
15	1.78	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
15	0.84	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
16	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
17	0.47	4745	0.09	419	0.168	495	0	\$0.00	YES	\$65.11	NO	\$0.00	
18	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
19	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00	
20	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
21	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
Total	7.709		0.304	1442.48	0.58	1702.126	0	\$0.00		\$390.66		\$0.00	
				Total \$ Exp	ense =	\$390.66							

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

213LITE.wk3

PREPARED BY: CHECKED BY:

JW CEL

EXIT SIGNS:

40

### **BUILDING NUMBER:**

213

Sheet 1 of 3

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

			On/Off		Good For		Unocc.
Room	# of	Fixture Description	During	Switch	Occup.	No. of	Lights
Na.	Fixtures		Survey	Yes/No	Sensor	Switches	On
7	8	4x2-2 lamp fluorescent	on	yes	no	1	no
24	4	4x2-4 lamp fluorescent	on	yes	no	1	no
24	8	4x2-2 lamp fluorescent	on	yes	по	1	по
8	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
12	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	по
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	по
Recption	2	4x2-4 lamp fluorescent	on	yes	yes	1	по
7	12	4x2-4 lamp fluorescent	on	yes	no	2	no
8	2	4x2-4 lamp fluorescent	on	yes	no	1	по
9	3	4x2-4 lamp fluorescent	on	yes	no	1	no
	5	4x2-4 lamp fluorescent	on	yes	no	1	yes
13		4x2-4 lamp fluorescent	on	yes	no	1	no
11_	6		on	yes	no	1	no
12	6	4x2-2 lamp fluorescent	on	yes	no	1	no
17	6	4x2-4 lamp fluorescent			no	1	no
21	3	4x2-4 lamp fluorescent	on	yes		1	по
23_	2	4x2-2 lamp fluorescent	off	yes	no	1	no
19	11	4x2-2 lamp fluorescent	off	yes	yes	1	no
20	3		on	yes	no	1	no
22	2		off	yes	по	2	no
67	11	4x2-4 lamp fluorescent	on	yes	no		
70	2		on	yes_	no	1	no
77	4		on	yes	no	1	yes
77	9	4x2-2 lamp fluorescent	on	yes	no	1	yes
71	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
72	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
73	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
75	8		on	yes	no	1	yes
74	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
76	19	4x2-2 lamp fluorescent	on	yes	no	1	yes
Photolab	14		on	yes	no	2	no
93	4		off	yes	no	1	no
96	1	<del></del>	off	yes	no	1	no
97	1		off	yes	no .	1	по
Microlab	1	<del></del>	off	yes	no	1	по
98	2		off	yes	по	1	no
100	16		on	yes	no	4	по
35	1		off	yes	no	1	no
Chem.Rm	<del>                                     </del>		on	yes	по	1	no
Chem.Hm 91	1 2		on	yes	по	1	по
79	2		on	yes	no	1	no
			on	yes	no	2	no
78	3		on	yes	no	2	no
108	4		on	yes	yes	<del>                                     </del>	no
107	2				no	1	по
109	1 2		off_	yes		<del>                                     </del>	no
110	3		on	yes	no	<del>                                     </del>	no
106	1 2	4x2-4 lamp fluorescent	on	yes	no		110

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

213LITE.wk3

PREPARED BY: CHECKED BY:

JW CEL

## **BUILDING NUMBER:**

213

Sheet 2 of 3

Schedule #1	M-F	600 to	1900	S-S	0 to	0
Schedule #2	M-F	0 to	0	s-s	0 to	0

		restricted to the second of the second	On/Off	- 4.2 1.893	Good For		Unoce.
Room	# of	Fixture Description	During	Switch	Оссир.	No. of	Lighte
No.	Lights		Survey	Yes/No	Sensor	Switches	Ōn
104	2	4x2-4 lamp fluorescent	on	yes	no	1	no
102	2	4x2-4 lamp fluorescent	on	yes	no	1	no
101	1	4x2-2 lamp fluorescent	on	yes	no	1	no
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
64	20	4x2-4 lamp fluorescent	оп	yes	по	1	по
59	5	4x2-4 lamp fluorescent	off	yes	по	1	по
Footwear	3	4x2-4 lamp fluorescent	off	yes	по	1	по
Laser Rm	3	4x2-4 lamp fluorescent	off	yes	no	1	no
Auto Rm	6	200 Watt Incandescent	off	yes	по	1	по
111	3	4x2-4 lamp fluorescent	on	yes	по	1	yes
111	3	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
113	4	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no
114	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	по
116	4	2x2-2 U-Bulb fluorescent	on	yes	по	1	no
117	20	4x2-4 lamp fluorescent	on	yes	по	2	yes
117	8	2x2-2 U-Bulb fluorescent	on	yes	по	2	yes
119	3	8'-2 lamp fluorescent	оп	yes	no	1	по
121	9	4x2-4 lamp fluorescent	on	yes	no	1	по
122	6	2x2-2 U-Bulb fluorescent	on	yes	по	1	по
123	21	8'-2 lamp fluorescent	on	yes	no	5	ПО
125	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
125	1	2x2-2 U-Bulb fluorescent	off	yes	по	1	yes
127	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
127	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
128	3	8'-2 lamp fluorescent	off	yes	по	1	по
129	5	8'-2 lamp fluorescent	on	yes	no	6	yes
129	12	4x2-2 lamp fluorescent	on	yes	no	6	yes
103	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
104	2		on	yes	yes	1	по
102	4	4x2-4 lamp fluorescent	on	yes	по	1	yes
105	2	4x2-4 lamp fluorescent	c::	yes	yes	1	по
108	12	4x2-4 lamp fluorescent	on	yes	no	2	ПО
109	6	4x2-4 lamp fluorescent	off	yes	по	2	по
110	10	4x2-2 lamp fluorescent	off	yes	no	1	no
112	10	4x2-4 lamp fluorescent	on	yes	no	2	по
115	14		on	yes	по	2	no
115	2	2x2-2 U-Bulb fluorescent	on	yes	по	2	no
118	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	ПО
120	9	4x2-4 lamp fluorescent	on	yes	no	2	по
124	14		on	yes	no	1	по
126	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
129	32		on	yes	no	1	no
58	4		on	yes	по	1	yes
56	4		on	yes	no	1	по
55	2	<u> </u>	on	yes	по	1	no
Clean-up	2	<del></del>	on	yes	по	1	yes
62	4	4x2-4 lamp fluorescent	on	yes	по	1	no

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

LOCATION:

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

FILE:

213LITE.wk3

PREPARED BY:

JW CEL

CHECKED BY:

**BUILDING NUMBER:** 

213

Sheet 3 of 3

 Schedule #1
 M-F
 600 to
 1900 S-S

 Schedule #2
 M-F
 0 to
 0

0 to \_\_\_\_

			On/Off		Good For		Unocc.
Room	# of	Fixture Description	During	Switch	Occup.	No. of	Lighte
No:	Fixtures		Survey	Yes/No	Sensor	Switches	On
52	2	4x2-4 lamp fluorescent	on	yes	no		yes
51	16	4x2-4 lamp fluorescent	on	yes	no	3	по
65	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
66	2	4x2-4 lamp fluorescent	оп	yes	yes	1	ПО
45	2	4x2-4 lamp fluorescent	оп	yes	yes	1	no
48	48	4x2-4 lamp fluorescent	оп	yes	no	2	no
48	22		on	yes	no	2	no
42	28		on	yes	по	1	no
42	6		on	yes	по	1	по
79	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
27	13	4x2-4 lamp fluorescent	on	yes	no	2	no
30	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
86	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	по
34	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
37	6	4x2-4 lamp fluorescent	off	yes	no	1	no
38	6		on	yes	yes	1	no
39	2	ļ	on	yes	yes	1	yes
94	235	4x2-2 lamp fluorescent	on	yes	no	1	no
95	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
95 96	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
97	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
	7	4x2-2 lamp fluorescent	off	yes	по	1	по
98	<u> </u>		on	yes	по	5	по
99	12		off	yes	no	2	no
99	1		off	yes	no	1	по
100_	1	2x2-2 U-Bulb fluorescent			no	1	по
101	1	4x2-2 lamp fluorescent	off	yes	no	2	yes
102	4		on	yes	<del> </del>	2	no
106	10		on	yes	no	1	yes
107	2	4x2-4 lamp fluorescent	on	yes	no	1	no
66	2		off	yes	no		
46	3		on	yes	no	1	yes
47	2		on	yes	yes	1	yes
71	2		on	yes	no	1	no
72	2		off	yes	no	1	no
73	1		off	yes	no	1	no
41	14		on	yes	no	2	no
39	23		on	yes	no	2	no
77	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
32	6		оп	yes	yes	2	yes
26	2		on	yes	yes	1	yes
25	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
28	2		on	yes	yes	1	no
29	3		On	yes	yes	1	no
33	3		оп	yes	no	1	no
35	2		off	yes	yes	1	по
90	5		on	yes	по	1	no
36	2	<u> </u>	off	yes	yes	1	no

PROJECT: FORT MoPHERSON & FORT GILLEM ESOS STUDY

### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

213LITE.wk3 FILE:

PREPARED BY: JW CEL

CHECKED BY:

Sheet 1 of 3

### **BUILDING NUMBER:**

% Unnoc. lights:

% Unnoc. lights: 19%

Gas Increase Factor 2.20E-04 MBtu/kWh

213

Cooling Factor (Energy) 1.19

			11.43 2.1		( <del></del>			<u> Nalasya dan 1</u>		Switches	1 <b>2</b> 2 1 1	
	Total	<b>.</b>	Lighting	Lighting	Total Gas	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	No. of	New	Suitable	Well	Suitable	Ceiling
Room	kW/Month	Hours 'On'	kW/Month	kWh	norease	Total kWh	New	Switches	for Wall	Sensor	for Celling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yr	Saved/Yr	Switches	Cost	Sensor	Cost	Sensor	Cost
7	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
24	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES_	\$65.11	NO	\$0.00
12	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
10	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
Recption	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
7	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
8	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
11	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
17	0.93	3393	0.00	0	0.000	0	Ó	\$0.00	NO	\$0.00	NO	\$0.00
21	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
19	0.09	3393	0.02	57	0.013	68	Ō	\$0.00	YES	\$65.11	NO	\$0.00
20	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
67	1.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.36	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.18	3393	0.03	115	0.025	137	Ó	\$0.00	YES	\$65.11	NO	\$0.00
72	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
73	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
76	1.69	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Photolab	1.25	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
93	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
97	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Microlab	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.31	3393	0.00	O	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
100	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Chem.Rr	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
91	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.31	3393	0.00	Ö	0.000	Ō	0	\$0.00	NO	\$0.00		\$0.00
78	0.47	3393	0.00	Ō	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
108	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
107	0.31	3393	0.06	200	0.044	238	Ö	\$0.00	YES	\$65.11	NO	\$0.00
109	0.31	3393	0.00	0	0.000	230	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	+	\$0.00
106	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.31	3333	0.00	1745.122	0.000	U		<b>Ф</b> О.ОО	INO	\$0.00 \$716.21	INO .	<b>\$0.00</b>

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY



CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**213** .

EMC PROJECT: #3105.000 22-Apr-92 DATE:

213LITE.wk3 FILE:

PREPARED BY:

CHECKED BY: CEL

Sheet 2 of 3

### **BUILDING NUMBER:**

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

						F	7.4	Maria Jana Aria	Cost of	Switches		
	Total		Lighting	Lighting	Total Gas		No. of	New	Suitable	Wali	Suitable	Ceiling
Room	kW/Month	Hours 'On'	kW/Month	kWh	Increase	Total kWh	New	Switches	for Wall.	Sensor	for Ceiling	Sensor
No.	Lighting	Per Year	Saved	Saved/Yr	(MBtu)/yi	Seved/Yr	1	Cost	Sensor	Cost	Sensor	Cost
104	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
64	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Footwear	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Laser Rm	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Auto Rm	1.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.28	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
114	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
116	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	0.74	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
122	0.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
123	4.41	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.31	3393	0.00	ō	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
125	0.09	+	0.00	0	0.000	0	0	\$0.00	NO_	\$0.00		\$0.00
127	0.47	·	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00
127	0.09			0	0.000	0	0		NO	\$0.00		\$0.00
128	0.63			0		0	0	\$0.00	NO	\$0.00		\$0.00
129	1.05		0.00	0	0.000	0	0		NO	\$0.00		\$0.00
129	1.07	<del></del>	0.00	0	0.000	0	0		NO	\$0.00		\$0.00
103	0.47			300	0.066	357	0		YES	\$65.11		\$0.00
104	0.31	<del></del>		200	0.044	238	0		YES	\$65.11		\$0.00
102	0.62			0	0.000	0	0		NO	\$0.00		\$0.00
105	0.31			200	0.044	238	0		YES	\$65.11		\$0.00
108	1.86			0	0.000	0	0		NO	\$0.00		\$0.00
109	0.93	<del></del>		0	0.000	0	0		NO	\$0.00		\$0.00 \$0.00
110	0.89			0	0.000	0	0		NO	\$0.00		
112					0.000	0	C		NO	\$0.00		\$0.00
115	2.17				0.000		C			\$0.00		\$0.00
115	0.18				0.000		C			\$0.00		\$0.00
118							C			\$0.00		\$372.00
120					0.000					\$0.00		\$0.0
124	<del></del>						(			\$0.00		\$0.0
126						0				\$0.00		\$0.0
129										\$0.00		\$0.0
58							(			\$0.00		\$0.0
56								\$0.00		\$0.00		\$0.0
55								\$0.00	NO	\$0.0		\$0.0
Clean -	<del></del>							\$0.00	NO	\$0.0		\$0.0
62			<del></del>					\$0.00	NO	\$0.0		\$0.0
- 02	0.64	5 5090	5,00	1611.03		1			1	\$260.4	4	

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

### **ECO:15-LIGHTING CONTROL**

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

**BUILDING NUMBER: 213** 

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh

Cooling Factor (Energy) 1.19

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: 213LITE.wk3

PREPARED BY: JW CHECKED BY: CEL

Sheet 3 of 3

							Coet of Switches							
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Tatal kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Well Sensor Cost	Sultable for Celling Sensor	Celling Sensor Cost		
52	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
51	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
65	2.48	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00		
66	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00		
45	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00		
48	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00		
48	7.44	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO_	\$0.00		
42	1.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
42	4.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
79	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
27	0.62	3393	0.12	400	0.088	476	0	\$0.00	NO	\$0.00	YES	\$0.00		
30	2.02	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00		
86	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00		
34	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	. \$0.00		
37	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
38	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
39	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00		
94	0.33	3393	0.03	119	0.026	141	0	\$0.00	NO	\$0.00	NO	\$0.00		
95	20.92	3393	0.00	7,10	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00		
96	0.62	3393	0.12	400	0.088	476	0	\$0.00	YES	\$65.11	YES	\$0.00		
97	0.02	3393	0.02	57	0.013	68	0	\$0.00	NO	\$0.00	NO	\$0.00		
98	0.09	3393	0.02	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
99	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
99	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
100	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
	0.09	3393	0.00	0		0	0	\$0.00	NO	\$0.00		\$0.00		
102	0.69	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
106		3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
107	1.55	3393	0.00	0	<del></del>	0	0	\$0.00	NO	\$0.00		\$0.00		
66	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00		\$0.00		
46	0.31	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11		\$0.00		
47	0.47	3393	0.06	200	0.000	238	0	\$0.00	NO	\$0.00		\$0.00		
71	0.31		0.00	0		0	0	\$0.00	NO	\$0.00		\$0.00		
72	0.31	3393 3393	0.00	0		0	0	<del></del>	NO	\$0.00		\$0.00		
73	0.31	3393	0.00	Ö	0.000	0	0		NO	\$0.00		\$0.00		
41	0.16 2.17	3393	0.00	0	0.000	0	0	<del></del>	NO	\$0.00		\$0.00		
39		3393	0.00	0		ō	0	\$0.00	YES	\$65.11		\$0.00		
77	3.57 0.31	3393	0.06	200	0.000	238	0	<del></del>	NO	\$0.00		\$0.00		
32		3393	0.08	600	0.132	713	0		YES	\$65.11		\$0.00		
26	0.93	3393	0.18	200	0.132	238	0		YES	\$65.11		\$0.00		
25 28	0.31 0.31		0.06	200		238	0		YES	\$65.11		\$0.00		
			0.06	200		238	0		YES	\$65.11		\$0.00		
29	0.31		0.09	300	<del></del>	357	0		NO	\$0.00		\$0.00		
33	0.47	<del></del>				337	0	<del></del>	YES	\$65.11		\$0.00		
35	0.47		0.00	0		238	0		NO	\$0.00		\$0.00		
90	0.31	3393	0.06	200					YES	\$65.11		\$0.00		
36	0.78	<del></del>	0.00	0		0	0		153	\$1,888.19		\$1,116.00		
Total	133.2		2.30736	7828.872	1./2235	9316.358	1	\$0.00		<b>₽1,000.</b>  ₹	<u> </u>	<del></del>		

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO: 15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 22-Apr-92 DATE:

935LITE.WK3 FILE:

PREPARED BY: CHECKED BY:

CEL

EXIT SIGNS:

**BUILDING NUMBER:** 

935

Sheet 1 of 1

 
 Schedule #1
 M-F
 600 to
 2100
 S-S

 Schedule #2
 M-F
 0 to
 0
 S-S
 0 to 0 to

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	Na. of Switches	Unocc. Lights On
140.	36	400 Watt Incandescent	оп	yes	no	1	по
	6	400 Watt Incandescent	on	yes	ПО	1	по
3		400 Watt Incandescent	on	yes	по	1	по
4	2	4x2-4 lamp fluorescent	on	по	yes	0	yes
<del></del>	2	75 Watt Incandescent	on	по	yes	Ö	yes
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
8	1	150 Watt Incandescent	on	yes	yes	1	yes
9	9		on	yes	no	2	yes
10	8		on	yes	yes	2	yes
	3		on	yes	yes	1	yes
11	9		оп	yes	yes	2	yes
13	4		on	yes	по	1	yes
14	4		on	yes	yes	1	no
15	1	4x2-2 lamp fluorescent	off	yes	по	1	yes
16	3		on	ves	no	2	yes
17	30		on	yes	по	3	no
	<del></del>	+ · · · · · · · · · · · · · · · · · · ·	off	yes	yes	3	по
18 19	15		off	yes	yes	2	no

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

**ECO:15-LIGHTING CONTROL** 

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000 DATE: 22-Apr-92

935LITE.WK3 FILE: PREPARED BY: JW

CHECKED BY: CEL

Sheet 1 of 1

### **BUILDING NUMBER:**

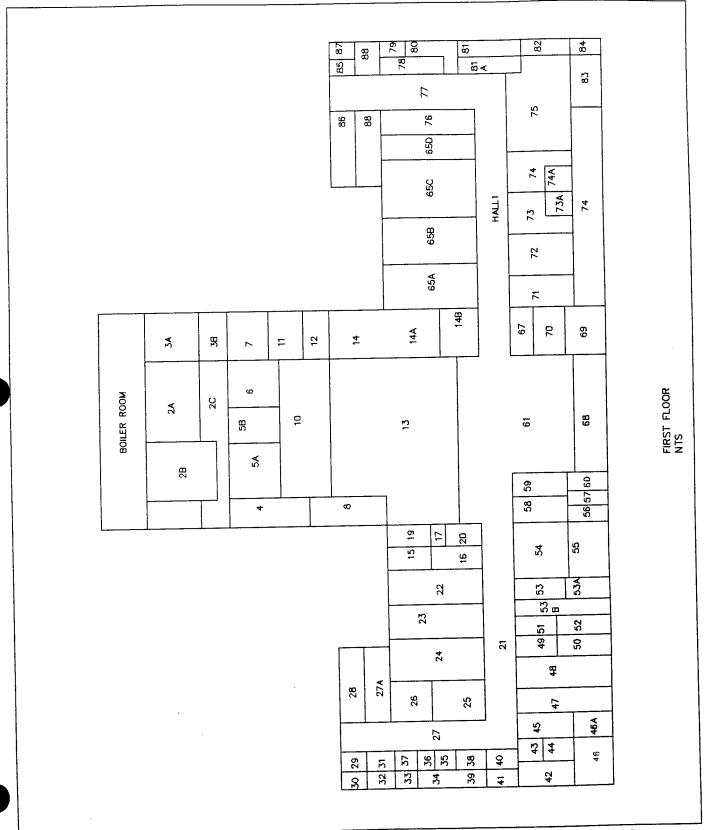
% Unnoc. lights:

Gas Increase Factor 1.27E-03 MBtu/kWh

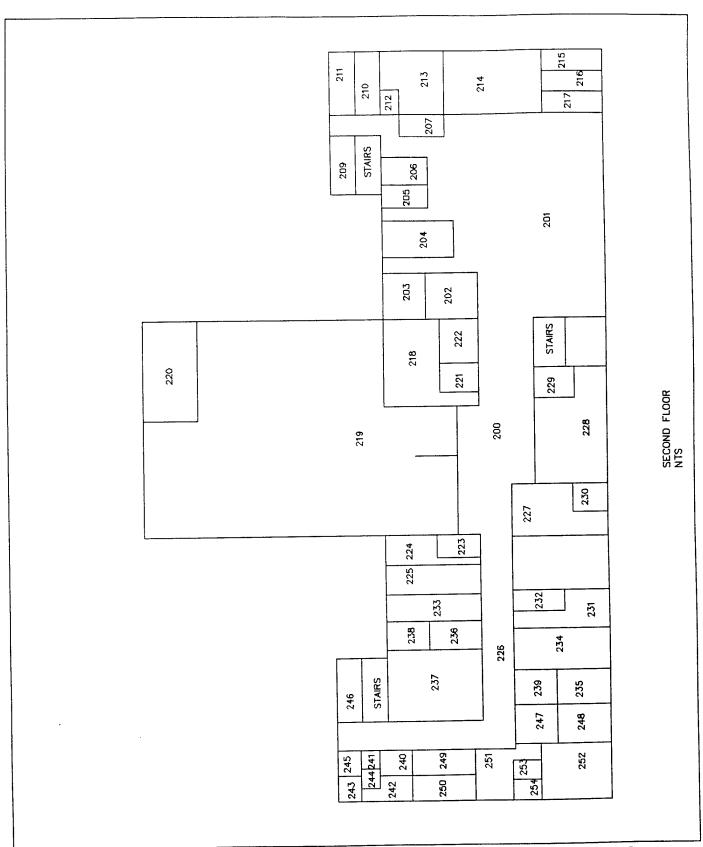
935

Cooling Factor (Energy) 1.3375

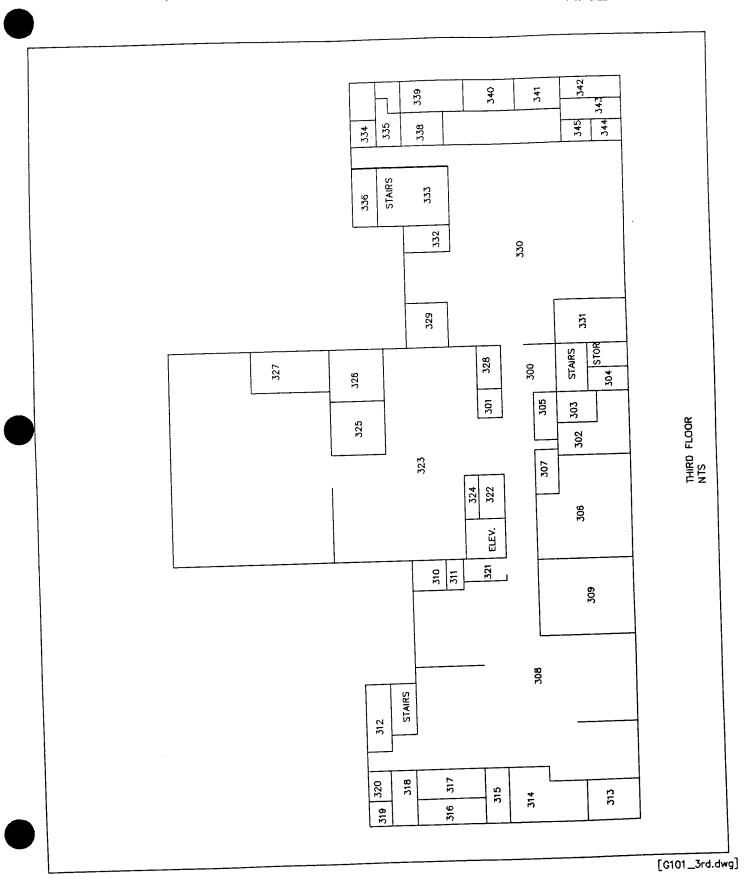
						[	Jr 14 A.	Cost of Switches					
Roam No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/vi	Total kWh	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Well Sensor Cost	Suitable for Calling Sensor	Celling Sensor Cost	
140.	14.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
2	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
3	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
4	0.31	3915	0.06	81	0.102	108	1	\$396.17	YES	\$65.11	NO	\$0.00	
<del></del>	0.15	3915	0.03	39	0.050	52	<u> </u>	\$396.17	YES	\$65.11	NO	\$0.00	
6	0.13	3915	0.05	199	0.252	266	· ·	\$0.00	YES	\$65.11	NO	\$0.00	
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00	
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00	
8	0.15	3915	0.03	112	0.142	149	0	\$0.00	YES	\$65.11	NO	\$0.00	
9	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
10	1.20	3915	0.23	893	1.134	1194	0	\$0.00	NO	\$0.00	YES	\$372.00	
2a	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00	
11	0.80	3915	0.15	596	0.757	797	0	\$0.00	NO	\$0.00	YES	\$372.00	
13	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
14	0.62	3915	0.12	461	0.586	617	0	\$0.00	NO	\$0.00	YES	\$372.00	
15	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
16	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
17	2.67	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00	
18	1.34	3915	0.25	993	1.261	1328	0	\$0.00	NO	\$0.00	YES	\$372.00	
19	0.89	3915	0.17	662	0.841	885	0	\$0.00	NO	\$0.00	YES	\$372.00	
Total	30.351		1.23956	4630.306	5.88049	6193.035	2	\$792.34		\$455.77		\$1,860.00	
				Total \$ Ex	pense =	\$3,108.11							

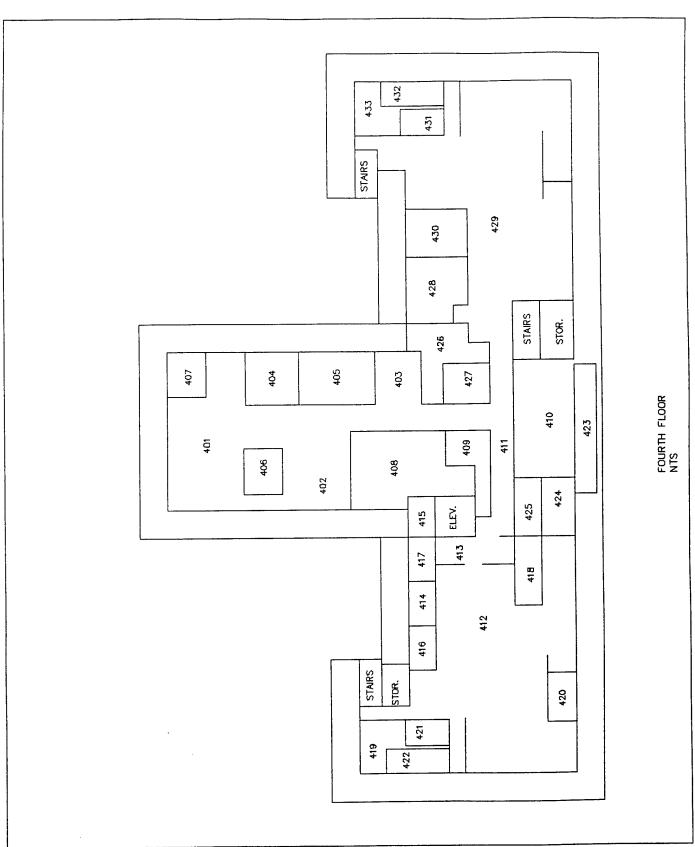


[G101\_1st.dwg]

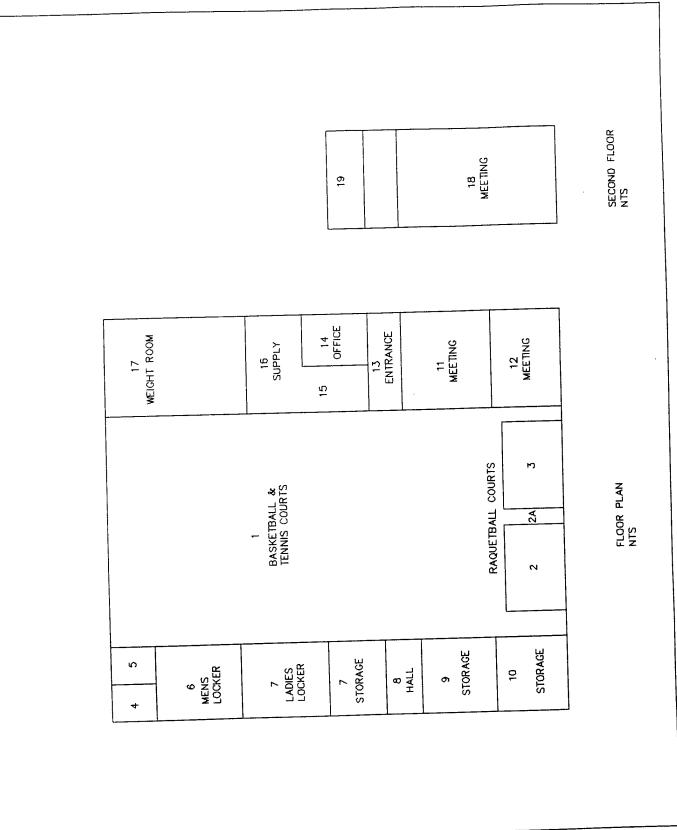


[G101\_2nd.dwg]





[G101\_4th.dwg]



[935.DWG]

ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS

LIFE CYCLE COS ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DAC FISCAL YEAR 1992 DISC ANALYSIS DATE: 07-16-92	A21-91-C-0097 RETE PORTION	NAME	NERGY SAV : ECO-187	INGS OPPORT EXIT SIGN	UNITI	025 062 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	·m·	2 - 1	D)		\$ \$ -\$	9234. 508. 554. 0. 10296.
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL	COST (-) SAVINGS, UNI	т со	ST & DISC	COUNTED SAVI	NGS	
UNIT COST FUEL \$/MBTU(1)						
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	218. 0. 0. 0.	\$ \$ \$ \$	1629. 0. 0. 0.	15.61 21.66 26.51 23.77 16.06		25425. 0. 0. 0.
F. TOTAL	218.	\$	1629.		\$	25425.
3. NON ENERGY SAVINGS(+)						
A. ANNUAL RECURRING (	+/-)			14 53	\$	15.
A. ANNUAL RECURRING ( (1) DISCOUNT FACT (2) DISCOUNTED SA	OR (TABLE A) VING/COST (3)	A X 3	A1)	14.55	\$	211.
C. TOTAL NON ENERGY I						
B IF 3D1 IS C IF 3D1B IS	QUALIFICATION CONTROL OF CONTROL	2F5 X O TO SIR O ITE	: .33) ITEM 4 = (2F5+3) M 4	01)/1E)		
4. FIRST YEAR DOLLAR SAV	VINGS 2F3+3A+	(3B1D	/(YRS EC	ONOMIC LIFE)	)\$	1643.
5. TOTAL NET DISCOUNTED						25636.
6. DISCOUNTED SAVINGS RA (IF < 1 PROJECT DOES						
7. SIMPLE PAYBACK PERIOR	(ESTIMATED)	S	SPB=1E/4	6.2	27	

### REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18 BUILDING 41

### Given:

# of Exit Signs = 4 signs - from field survey

Existing Bulb Wattage = 40 Watts - from field survey

Improved Bulb Wattage = 10 Watts - from manufacturer's data

Gas Cost = \$4.67 / MBtu - from utility rate analysis

Electric Cost = \$0.0255 / kWh - from utility rate analysis

Demand Cost = \$8.85 / kW - from utility rate analysis

### Existing Energy Usage:

 $(4 \text{ signs})^*(40 \text{ Watts / sign}) = 160 \text{ Watts}$  $(0.16 \text{ kW})^*(8,760 \text{ hrs / yr}) = 1,402 \text{ kWh}$ 

### Improved Energy Usage:

 $(4 \text{ signs})^*(10 \text{ Watts / sign}) = 40 \text{ Watts}$  $(0.04 \text{ kW})^*(8,760 \text{ hrs / yr}) = 350 \text{ kWh}$ 

### Peak Demand Savings:

(0.16 - 0.04 kW) = 0.12 kW

### **Annual Energy Savings:**

- Electric: (1,402 - 350 kWh) = 1,052 kW - Gas: = 0 MBtu

### **Annual Energy Cost Savings:**

 $(0 \text{ MBtu})^*(\$4.67 / \text{ MBtu}) + (1,052 \text{ kWh})^*(\$0.0255 / \text{ kWh}) + (0.12 \text{ kW})^*(\$8.85 / \text{ kW})^*(4 + .95 * 8) = \$39 / \text{ yr}$ 

### Annual Increased recuring cost

(\$7.95) - (2 \* \$2.25) \* (8,769 yr / 10,000 hr) = \$3.02 / yr / fixture 4 fixtures = 4 \* \$3.02 = \$12.08 / yr

### **Estimated Construction Cost:**

\$38.00 / sign - from engineer's cost estimate

(\$38.00 / sign)\*(4 sign) = \$152

\$152 + (\$152 \* .055 SIOH) + (\$152 \* .06 DESIGN) = \$169

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM ECO: REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

#3105.000 **EMC PROJECT:** DATE:

**CAMERAN DIBAI GEXITLIT.WK3** 07/15/92 PRPARED BY:

FILE:

CHECKED BY:

	ENERGY	DISCOUNT
	COST	FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	
<b>ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR</b>		

		ANNOAL	ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNUAL ANNUAL	ANNOAL	TOTAL			
	NUMBER		ELECTRIC	NAT GAS	ENERGY	ENERGY	DEMAND	NON-ENE	ANNOAL	CONST.		SIMPLE
	Ъ			SAVINGS	SAVINGS		SAVINGS	SAVINGS	SAVINGS	COST	SIR	<b>PAYBACK</b>
BLDG	FIXTURES	(KW)		(MBtu)	(MBtu)	<b>(</b>	(\$)	<b>(</b>	<b>(</b>	(\$)		(YRS)
G101			18396	0	83	\$471	\$216	(\$211.40)	\$475	\$2,966	2.5	6.2
103	6	0.27	2365.2	0	80	\$61	\$28	(\$27.18)	\$61	\$381	2.5	6.2
207	48		12614.4	0	43	\$323	\$148	(\$144.96)		\$2,034	2.5	6.2
213		1.2	10512	0	88	\$269	\$123	(\$120.80)	\$271	\$1,695	2.5	6.2
G400	48	4.	12614.4	0	43	\$323		(\$144.96)		\$2,034	2.5	6.2
G401	8		5256	0	18	\$135		(\$60.40)	\$136	\$847	2.5	6.2
935	8	0.24	2102.4	0	7	\$54	\$25	(\$24.16)	\$54	\$339	2.5	6.2
TOTAL	670	2 90	A NABECA	6	917 QKG	10	1634 83 748 39	38 FF7_	1649.4	\$10 29B	25	6.2

COST ESTIMATE ANALYSIS   DMACA21-9-C-097		70%	-		-	ON MOLTATIVA	CONTRACT NO.			EFFECTIVE PRICING		DATE PREPARED	
ESOS Study  Channilly  No. Of Unit MHY Total Unit  Units Mees Unit Hrs Price  Units Mees Unit Hrs Price  1 EA 1 0.5 \$21.17 \$10.59  Fige  1 15%  EQUIPMIN  LABOR  EQUIPMIN  Unit  Price  Cost Price  Unit  Price  Studies  Studies  EQUIPMIN  STUDIES  EQUIPMIN  STUD	COST ESTIMATE	ANALTON	Λ		-		7000			DATE APR 92		ē	T
ESOS Study  Outentity  No. Of Unit MH/ Total Unit Hrs Price Cost Price  Units Mess Unit Hrs Price Cost Price  1 EA 1 0.5 \$21.17 \$10.59  Price Price  1 0.5 \$21.17 \$10.59  Price Price Cost Price  1 0.5 \$21.17 \$10.59  Price Price Cost Price  1 0.5 \$21.17 \$10.59  Price Price Cost Price						V CODE A	CODEB	CODEC		DRAWING NO.		SHT OF	
Other   Coupment   C		Study				V CODE V		٦					
No. Of Unit MH/ Total Unit Price Cost Price Unit Price Unit Price Cost Price	COATON Et McPharson & Ft Gillem					OTHER			1=	<b>ESTIMATOR FIMG</b>		CHECKED BY CE	1
Ouantity Mess Unit Hrs Price Cost Price Price   Price	JOANION TI. Mar Ingland and Commercial							1	MATERIA	Į.	TOTAL	SHIPPING	
No. Of Unit Mrty Total Unit Price Cost Price  Units Meas Unit Hrs Price Cost \$10.59  I EA 1 0.5 \$21.17 \$10.59  I EA 1 0.5 \$21.17 \$10.59  I EA 1 1 0.5 \$21.17 \$10.59  I EA 1 1 0.5 \$21.17 \$10.59  I EA 1 1 0.5 \$21.17 \$10.59  I EA 1 1 0.5 \$21.17 \$10.59  I EA 1 1 0.5 \$21.17 \$10.59  I EA 1 15%  I EA 1 1 0.5 \$21.17 \$10.59		Ottontity	-	¥	Ä		ECCO.		1			Chit	Total
Units     Meas     Unit     Hr     Price     Cost     Price       1     EA     1     0.5     \$21.17     \$10.59       1     5     1     1     1     1       1     5     1     1     1     1       1     1     5     1     1     1       1     1     5     1     3     1       1     5     1     5     1     3       1     5     1     5     1     3       1     5     1     5     1     3       1     5     1     5     1     3       1     5     1     5     1     3       1     5     1     5     1     3       1     5     1     5     1     3     1       1     5     1     5     1     3     1       1     5     1     5     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3     1     3 <td< th=""><th></th><th></th><th>1</th><th></th><th>1</th><th></th><th>tie :</th><th><b>1</b></th><th>Price</th><th>Cost</th><th>į</th><th>-</th><th>ž</th></td<>			1		1		tie :	<b>1</b>	Price	Cost	į	-	ž
1 EA 1 0.5 \$21.17 31  1 15.4 10.6 \$21.17 31	TASK DESCRIPTION	Units Mea	ļ	I		Cost	Price	1803	\$15.00		\$25.59		
25.1 15%	XIT SIGN RETROFIT KIT	1 EA			_	#10.09							
ALB-TOTAL  15%  16%  16%  16%  16%  16%  16%  16%				-				-					T
7AL 3AD, BOND 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL 1188-TOTAL			-										
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TAL SAD, BOND 1.86 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.66 - TOTAL 1.67 - TOTAL 1.68 - TOTAL			_					-					T
TAL SAD, BOND  1.86 - TOTAL  1.186				-									
M. I.B.—TOTAL. 15% GENCY 15%													
I   I   I   I   I   I   I   I   I   I													
TAL   AD, BOND			-		 	-							
I.M.  I.M.			+	-	-								
TAL SAD, BOND  15%  15%  15%  15%  15%  15%			+	-									
I.M.  SAL), BOND  1.0%			-	_	-								
I.M. 15% 15% 15% 15% 15% 15% 15% 15% 15% 15%								+					
TAL AD, BOND 1184 14B-TOTAL GENCY 15% 15%								+					
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TAL  AD, BOND  10%  10%  15%  15%  15%  15%  15%  15%						-							
TAL  AD, BOND  LIB.—TOTAL  GENCY  15%  15%  15%								+					
TAL AD, BOND 10% 10% GENCY 15% 15%											-		
TAL AD, BOND 10% 10% 15% 16% 16% 16% 16% 15%			-								-		
FAL. SAD, BOND 10% 10% 15% 15% 15% 15% 15%			-					-					
FAL. SAD, BOND 10% 10% 10% 15% 15% 15% 15%			-	-									
AD, BOND 15% 10% 10% 15% 6ENCY 15%								+					
AD, BOND 15% 15% 10% 10% 15% 15% 15% 15%										615.00	\$25.59	65	
AD, BOND 15% 10% 10% 15% 15% 15% 15% 15% 15% 15% 15%			-			\$10.5	63	1		8 2		*	
AD, BOND 19% 10% 10% 15% 15%	SUBTOTAL	1	-			51.5	93			2		şç	1
IUB-TOTAL 15%	OVERHEAD, BOND	10%	-		-	\$1.0	92			9		9	
GENCY 15%	PROFIT	8	+			613	23			\$18.73		3 8	
GENCY 15%	COST SUB-TOTAL		+	-	-		2 8			\$2.81		8 5	
	NO SENCY	15%	1		-	- 1	3 8			\$21.56	8/30°/2	8/	
					-	.c.	7	-					
	IOIAL STREET		ļ										

ECO-11, REPLACE STREET LIGHTS

FI	STALLATION OJECT NO. SCAL YEAR	& LOCATION: & TITLE: DAC 1992 DISC	T ANALYSIS SU INVESTMENT IN FT. GILLEM PA21-91-C-009 PRETE PORTION ECONOMIC L	REGIO TENE NAME:	ON NOS RGY SAV ECO-11	. 4 CENSUS VINGS OPPOI RPLACE STI	S: 3 RTUNITY REET LI	SURVEY
1.	B. SIOH C. DESIG	RUCTION COST N COST GE VALUE COS		c – 1D)				2405. 133. 145. 0. 2683.
2.		VINGS (+) / DATE ANNUAL	COST (-) SAVINGS, UNI	IT COST	& DISC	COUNTED SA	/INGS	
	FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUA SAVIN	L <b>\$</b> GS(3)	DISCOUNT FACTOR (4)	DISC SAVI	COUNTED INGS (5)
	A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ 7.47 \$ .00 \$ .00 \$ 4.67 \$ .00	17. 0. 0. 0.	\$ \$ \$ \$	126. 0. 0. 0.	15.61 21.66 26.51 23.77 16.06		1962. 0. 0. 0.
			17.					1962.
3.	NON ENERG	Y SAVINGS(+)	/ COST(-)					
	A. ANNUAL	RECURRING (	+/-) OR (TABLE A) VING/COST (3			14.53	\$	174.
	(2) D	ISCOUNTED SA	VING/COST (32	A X 3A1	)	22722	\$	2528.
	C. TOTAL	NON ENERGY D	ISCOUNTED SAV	VINGS (+	)/COST	(-)(3A2+3B	14)\$	2528.
	(1) 2	5% MAX NON E A IF 3D1 IS B IF 3D1 IS C IF 3D1B IS	QUALIFICATIONERGY CALC (2 = OR > 3C GO < 3C CALC = > 1 GO TO < 1 PROJECT	2F5 X . D TO IT SIR = D ITEM	33) EM 4 (2F5+3I 4	01)/1E)		
4.	FIRST YEA	R DOLLAR SAV	INGS 2F3+3A+	(3B1D/(	YRS EC	ONOMIC LIF	E))\$	300.
5.	TOTAL NET	DISCOUNTED	SAVINGS (2F5	+3C)			\$	4490.
-	(IF < 1	D SAVINGS RA PROJECT DOES	TIO NOT QUALIFY Y for ECIP for	) ·		1E)= 1 for inform		only.
	_		(ESTIMATED)		=1E/4		.95	<u>-</u> -

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO-11: REPLACE EXTERIOR LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: DATE:

EXT\_LITES.WK3 JIM WATTERS #3105.000 09/01/92

PRPARED BY:

CHECKED BY:

	ENERGY	DISCOUNT
	COST	FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW
ECONOMICLIFE	25 YRS	
ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR		

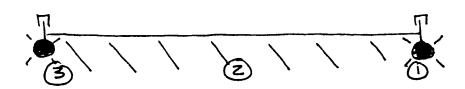
				ANNUAL	ANNUAL ANNUAL ANNUAL	INNUAL	TOTAL	ANNOAL	ANNIA	ANNUAL	TOTAL			
Existing		Replacement		DEMAND	MAND ELECTRIC NAT GAS	VAT GAS	-	ENERGY	DEMAND	NH-NON	ANNIA	TSNOO		CIMDIE
Bulb Wattage Existing	Number	Bulb Wattage	Number Bulb Wattage Replacement SAVII	SAVINGS	SAVINGS SAVINGS	SAVINGS	SAVING	S SAVINGS S	SAVINGS	SAVINGS	SAVINGS	COST	Œ	PAYRACK
(WATTS) Bulb Typ	e of Bulbs	(WATTS)	Bulb Type of Bulbs (WATTS) Bulb Type	(kW)	(kWH)	(MBtu)	(MBtu)	9	(\$)	(\$)	9	( <del>g</del> )	 5	(VBS)
1500 QUARTS	0	400	400 HPS*	0		<u> </u>	0	98	\$0		0\$	0\$		200
500 QUARTS	5	200	200 HPS*	0	4927.5	0	17	\$126	\$0	\$174	\$300		17	O
400 MERCURY	. 2	360	360 HPS	0	262.8	0	-	\$7	80	O\$	\$7	İ		26.2
175 MERCURY	122		150 HPS	0	10019.3	0	34	\$256	0\$	O\$	\$256	\$9 114	2 6	2.0.7
										3			5	2

arson & Ft. Gillem arson & Ft Gillem No No TXTURE									_	CP APP 92			
Ft. McPherson & Ft. Gillem ESOS Study  N. Ft. McPherson & Ft Gillem  A LIGHTING  SECRIPTION  USLAMP w/ FIXTURE  UD, BOND						DACA 21 - 9	DACA 21 -91 C-0097			ב ב ב		22Apr92	
2 5	•					X CODE A	CODEB	CODEC		DRAWING NO.		SHT OF	
8 5						N N N N N N N N N N N N N N N N N N N				ESTIMATOR PING	PMG	CHECKED BY CE	병
2 5	Quantity			LABOR			EQUIPMENT	ENT	MATERIAL	3IAI.	TOTAL	SHIPPING	9
ח	<u> </u>	) it	MH/	Total	Cait		Chit		Chit			Coit	Total
		Meas	Unit	Hrs	Price	Cost	Price	Cost	Price	Cost		ž	₹
	1 EA	A	4	4	\$21.17	\$84.68			\$275.00	\$275.00	\$329.68		
	15%					\$12.70				\$41.25	\$53.95		
	10%					\$8.47				\$27.50	\$35.97		
	-					\$105.85				\$343.75	"		
	15%			_		\$15.88				\$51.56			
						\$121.73				\$396.31	\$517.04		
										00 0104	4004 60		
200 W HPS LAMP w/ FIXTURE	1 E	₽ E	4	4	\$21.17	\$84.68			\$250.00	\$250.00			
	15%					\$12.70				\$37.50			
	10%	_				\$8.47				\$25.00			
COST SUB-TOTAL	-					\$105.85				\$312.50	*		
	15%	-				\$15.88				\$46.88	$\perp$		
		_				\$121.73				\$359.38	\$481.10		
360 W HPS LAMP	1 E	EA	-	-	\$21.17	\$21.17			35		"		
Q	15%					\$3.18				\$5.25			
	10%					\$2.12				\$3.50			
COST SUB-TOTAL						\$26.46				\$43.75			
	15%					\$3.97				\$6.56		8	
TOTAL						\$30.43				\$50.31	\$80.74		
	,	1	-	+	601 17	401 17			25	\$25.00	\$46.17		
	—	5	-	-		\$3.18				\$3.75	\$6.93		
DEDCETT CALL BOXED	2 2		-			\$2.12				\$2.50		2	
SI IR - TOTA						\$26.46				\$31.25			
	15%					\$3.97				8.28		9	1
						\$30.43				\$35.94	\$66.37	7	
	-												
		-											
											-		

Denver • Colorado Springs • Atlanta • Germany

JOB Fi. Mc	PHERSON /	
SHEET NO		OF
CALCULATED BY	CRL_	DATE 7/21/92
CHECKED BY		DATE

STREET LIGHT READINGS
PARKING LOT BEHIND B. 200

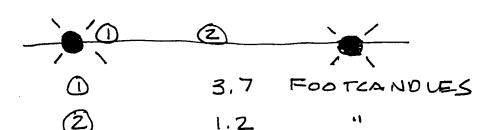


SCALE \_



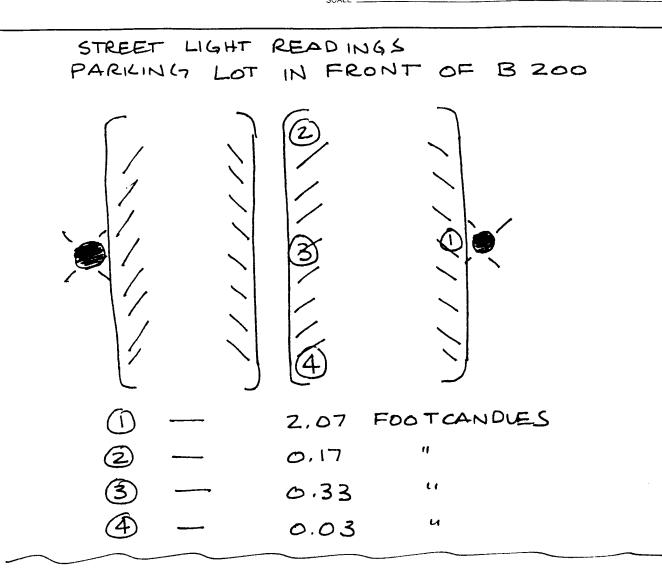
- 1 Z.07 FOOTCANDLES
- Z 0.35 "
- 3 Z,10 "
- (4) 0,37 " (5) — 0.10 "
- 6 0.35 "

STREET BEHIND PX



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JOB FT. M.	PAERSON		
SHEET NO.	EMC# 3105	OOO OF	
CALCULATED BY	CEL	DATE _	7/21/42
CHECKED BY		DATE _	
COME			



CROSS WALK IN FRONT OF BLDG 200

0.80 FOOTCANDLES

E	М	С	ENGINEERS,	INC.

Denver • Colorado Springs • Atlanta • Germany

JOB FT. MC	PHERSON / EMC # 31	(GILLEM
CALCULATED BY	Che	DATE 7/21/92
CHECKED BY		DATE
SCALE		

STREET LIGHT READINGS STREET IN FRONT OF B, 200

`(3)	(2)	₾`ੑ	
工		\ <u>T</u> _	_
① —	3,4 F	OOTCANDLES	

- 0,13
- 11 - 3,4

STREET IN FRONT OF B, 168



- 0.17 FOOT CAN DUES 0.09 " 0.18 "

	JOB FT, MCPHERS	3105,000
E M C ENGINEERS, INC.  Denver • Colorado Springs • Atlanta • Germany	CALCULATED BY CHECKED BY	
	SCALE	

STREET LIGHT READINGS
BLDG PARKING LOT
111111111111111111111111111111111111111
4
19/// B/// B///
1 - 2.47 FOOTCANDUES 2 - 0.23 " 3 - 2.33 " 4 - 0.64 "

Flg. 14-18. Recommended Maintained Illuminances for Open and Covered Parking Facilities

			Open Parklin	g Facilities				
For Vehicular Traffic For Pedesh					strian Salety	For	Pedestrian S	ecurity
Level of Activity	Lux	Footcan- dles *	Uniformity Ratio	Lux	Footcan- dles**	Lux'	Footcan- dles*	Uniformity Ratio
Low activity	5	0.5	4:1	2	0.2	9	0.8	5:1
Medium activity	1.1	1	3:1	6	0.6	22	2	5:1
High activity	22	2	3:1	10	0.9	43	4	5:1

		Day	Night		
Areas	Lux	Footcandles	Lux*	Footcandles*	
General parking and pedestrian areas	54	5	54	5	
Ramps and corners	110	10	54	5	
Entrance areas	540	50	54	5	
Stairways and lobbys (refer to Fig. 2-2)					

<sup>\*</sup> Average on pavement

the "High" activity lighting levels may be required, but while the game is being played or during hours of reduced activity the "Medium" or "Low" activity lighting levels may be adequate.

### ROADWAY ILLUMINATION DATA AND CALCULATIONS

The following is an example of a simple and straightforward calculation procedure to determine average illuminance and illuminance at a specific point on a roadway. For a detailed treatment of the subject, including calculations for high-mast and pedestrian walkway lighting, the reader is referred to Reference 1.

### Determination of Average Illuminance

The average illuminance over a large pavement area in terms of lux (footcandles) may be calculated by means of a "utilization curve" of the type shown in Fig. 14-19.

Utilization Curves. Utilization curves, available for various types of luminaires, afford a practical method for the determination of average illuminance over the roadway surface where lamp size, mounting heights, width of roadway, overhang and spacing between luminaires are known or assumed. Conversely, the desired spac-

ing or any other unknown factor may readily be determined if the other factors are given.

The Coefficient of Utilization, as shown in Fig. 14-19, is the percentage of rated lamp lumens which will fall on either of two strip-like areas of infinite length, one extending in front of the luminaire (street side), and the other behind the luminaire (house side), when the luminaire is level and oriented over the roadway in a manner equivalent to that in which it was tested. Since roadway width is expressed in terms of a ratio of luminaire mounting height to roadway width, the term has no dimensions.

Light Loss Factors. There are a number of causes of light loss. They are listed on page 4-21. For each cause, a factor can be determined. All individual factors can be multiplied together to obtain one total light loss factor. Some factors, usually due to less than ideal operating conditions, exist initially and continue through the life of the installation. They may, however, have too little effect to justify correction or be too costly to correct. The significant light loss factors in roadway calculations are:

Lamp Lumen Depreciation. Information about lamp lumen depreciation is available from manufacturers' tables and graphs for lumen depreciation and mortality of the chosen lamp. Rated average life should be determined for the specific hours per start; it should be known when burnouts will begin in the lamp life cycle. From these facts, a practical group relamping cycle will be established and then, based on the hours elapsed to lamp removal, the specific lamp lumen depreciation (LLD) factor can be determined.

<sup>\*\*</sup> Minimum on pavement

<sup>· · ·</sup> Average on payment—sum of electric lighting and daylight

### APPENDIX D-2 MCA PROJECT 2

### ECO-19, PREVIOUS LIGHTING REVIEW STUDY, FOR LIGHT FIXTURE REPLACEMENTS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: GECO25 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT A. CONSTRUCTION COST 2135242. B. SIOH 117439. C. DESIGN COST 128115. 0. D. SALVAGE VALUE COST

2. ENERGY SAVINGS (+) / COST (-) ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)
A. ELECT B. DIST C. RESID D. NAT G E. COAL	\$ .00 \$ .00	10143. 0. 0. 0.	\$ 75781. \$ 0. \$ 0. \$ 0. \$ 0.	15.61 21.66 26.51 23.77 16.06	1182934. 0. 0. 0. 0.
F. TOTAL		10143.	<b>\$</b> 75781.		\$ 1182934.

2380796.

- 3. NON ENERGY SAVINGS(+) / COST(-)
  - 130378. A. ANNUAL RECURRING (+/-)14.53 (1) DISCOUNT FACTOR (TABLE A) 1894392. (2) DISCOUNTED SAVING/COST (3A X 3A1)
  - C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)\$ 1894392.
  - D. PROJECT NON ENERGY QUALIFICATION TEST

E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)

- (1) 25% MAX NON ENERGY CALC (2F5 X .33) 390368.

  - A IF 3D1 IS = OR > 3C GO TO ITEM 4
    B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .66
    C IF 3D1B IS = > 1 GO TO ITEM 4
    D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY
- 4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 206159.
- \$ 3077327. 5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)
- 6. DISCOUNTED SAVINGS RATIO (SIR) = (5 / 1E) =(IF < 1 PROJECT DOES NOT QUALIFY) \*\*\*\* Project does not qualify for ECIP funding; 4,5,6 for information only.
  - 11.55 SPB=1E/4 7. SIMPLE PAYBACK PERIOD (ESTIMATED)

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 19 - PNL Lights

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

PREPARED BY: R. GERRANS CHECKED BY:

EMC PROJECT: #3105.000

15-Jul-92

DATE:

FILE: ECO-19.WK3

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savinds	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / KW	14.53 UPW

Economic Life: 15 yrs

SIMPLE PAYBACK (yrs)	10.9	12.0	11.5
SIMI PAYE (yr			
SIR	1.4	1.2	1.3
CONST COST (\$)	\$854,105	\$127,754 \$1,526,690	206,159 2,380,795
TOTAL ANNUAL SAVINGS (\$/yr)	\$78,405	\$127,754	206,159
ANNUAL NON- ENERGY SAVINGS (\$/yr)	<b>\$</b>	\$0	0
ANNUAL DEMAND SAVINGS (\$/yr)	\$49,585	\$80,793	130,378
ANNUAL ENERGY SAVINGS (\$/yr)	\$28,821		75,781
TOTAL ENERGY SAVINGS (MBtu/yr)	11	6,280	10,134
ANNUAL GAS SAVINGS (MBtu/vr)	0	0	0
BLDG # DEMAND ELECTRIC GAS SAVINGS SAVINGS (kW) (kWh/vr) (MBtu/vr)	483 1.130.220	787 1,841,580	,270 2,971,800
PEAK DEMAND SAVINGS (KW)	483		÷
BLDG #	Office	Warehouse	TOTAL

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM ECO: 19 - PNL Lights

CLIENT CONTRACT NO: DACA21-9-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

PREPARED BY: R. GERRANS CHECKED BY:

FILE: ECO-19.WK3 DATE: 2-APR-92

EMC PROJECT: #3105.000

2340 hrs / yr Operation:

Bldg. Type	Exist Demand	Imprvd		d Demand s Savings	Electric Usage Savings	Installation Cost
	(KW)	(KW)	(KW)	(KW)	(KWN/yr)	₽
Warehouse	1,705	918	0	787		1,841,580 \$1,369,229
Office	1,201	718	0	483	1,130,220	\$766,014

D-	2	•

TRI-SERVICE MILITARY CONSTRUCTION PROGRAM (MCP) INDEX

CALENDAR YEAR	*1990	*1991	1992	1993	1994	1995	1996
JANUARY	1676	1742	1810	1875	1938	1999	
FEBRUARY	1679	1746	1.8 1.3	1878	1941	2002	
MARCH	1682	1750	1816	1881	1944	2005	
APRIL	1.686	1753	1.8 1.9	1885	1947	2009	
MAY	1693	1760	1826	1891	1.953	2015	
JUNE	1.700	1767	1833	1897	1959	2021	•
JULY	1706	1773	1839	1904	1966	2027	
AUGUST	1713	1780	1.846	1910	1972	2033	
SEFTEMBER	1720	1787	J.853	1916	1978	2039	
OCTOBER	1.726	1793	1.859	1922	1984	2045	
HOVEMBER	1731	1799	1864	1927	1981		
DECEMBER	1736	1805	1869	1932	1990		

mple: (For 10 Month Construction Period)

Submittal Date Bid Opening Date Contract Award Date Midpoint of Construction	- 1 Sept 90 - 1 Apr 91 - 1 May 91 - 1 Oct 91	1720 13 Months
Cost Growth Factor =	1793 / 1720 =	1.0424 Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

\* Historical

Cost Growth Factor = 1819/1676 = 1.0853 use 1.09

### FEASIBILITY STUDY FOR LIGHTING SHARED ENERGY SAVINGS PROJECT FORT McPHERSON AND FORT GILLEM, GEORGIA

U.S. Army Corps of Engineers Huntsville Division Contract DACA87-89-D-0007 Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a 2 x 4 or a 2 x 2 louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at \$1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at \$2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

### 3.7 CAPITAL COST ESTIMATE

### 3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of \$1,255,900 (in 12/89 dollars). This does not include \$273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is \$253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at \$25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

### 3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be \$1,294,120 for both Fort Gillem (\$702,765) and Fort McPherson (\$591,355 including \$244,483 for CCF), including the Comand and Control Facility. Unlike the warehouses, no supply rewiring is required.

### 3.8 MAINTENANCE COST ESTIMATE

### 3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is \$53,611.

### SECTION 4

### ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	Fort Gillem	Fort McPherson	<u>Total</u>
Existing load (kW) Future loads (kW) Savings (kW) Percent savings	1,201 <u>718</u> 483	1,217 669 548	2,418 1,387 1,031 43%

In the CCF alone, the load will be reduced from 507 kW to 255 kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	Incremental Usage (kWh)	Rate <u>(\$/kWh)</u>
<pre>&lt;300 hr/mo * Billing Demand: (up to maximum of 1,961,500 kWh)</pre>	50,000 150,000 800,000 961,400	0.05710 0.05590 0.04150 0.03950
>300 hr/mo * Billing Demand:	Balance of kWh	0.01110

In addition, a fuel charge of \$0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from 0.066/kWh to 0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

### OFFICE (ALL) POWER COST

	onthly Energy ich Includes		Existing	System	Modified	System
	Incr.			534 kWh/Mo		314 kWh/Mo
<u>Hr/Mo</u>	<u>kWh</u>	Rate	kWh	Cost	<u>kWh</u>	Cost
<300	50,000	\$0.0571	50,000	\$ 2,855	50,000	\$ 2,855
.5	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	. 0	0	0	0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566 \$30,074	270,314	\$ 4,337 \$18,495
		Avg	. Rate	\$0.064/kWh		\$0.068/kWh

### COMMAND AND CONTROL FACILITY POWER COST

Exis	ting Syst	cem			Modified Syste	em
	<u>kWh</u>	@ Avg. rate from above	Cost	<u>kWh</u>	@ Avg. rate from above	Cost
Lighting Costs:	98,865	\$0.064/kWh	\$6,327	49,725	\$0.068/kWh	\$3,381
Differential Air Cond. Costs:	Base		base \$6,327	-15,379		-1,046 \$2,335

### APPENDIX D-3 LOW-COST OR NO-COST ECO ECO-8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ENERGY CONSERVATION INSTALLATION & LOCATION: PROJECT NO. & TITLE: DACK FISCAL YEAR 1992 DISCH ANALYSIS DATE: 07-15-92	121-91-C-0097	ENERGY SAV. JAME: ECO-8 W	ATER FLOW RI	1.06 3 JNITY ESTRIC	2 SURVEY
1. INVESTMENT A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COS E. TOTAL INVESTMENT	T (1A + 1B + 1C	- 1D)		\$ \$ \$ - \$	830. 46. 50. 0. 926.
2. ENERGY SAVINGS (+) / ANALYSIS DATE ANNUAL	SAVINGS, UNI	T COST & DISC	COUNTED SAVI	NGS	
UNIT COST	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR (4)	DISCO	OUNTED NGS (5)
A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	0. 0. 0. 99. 0.	\$ 0. \$ 0. \$ 0. \$ 462. \$ 0.	11.11 14.26 16.89 14.45 11.21		0. 0. 6681. 0.
F. TOTAL	99.	\$ 462.	V	\$	6681.
3. NON ENERGY SAVINGS (+	) / COST(-)				550.
A. ANNUAL RECURRING (1) DISCOUNT FACT (2) DISCOUNTED S	(+/-) TOR (TABLE A)	- v 251)	10.59	•	5825.
(2) DISCOUNTED S. C. TOTAL NON ENERGY	AVING/COST (3)	A X 3A1) VINGS(+)/COST	(-)(3A2+3Bd	·	
D. PROJECT NON ENERG  (1) 25% MAX NON  A IF 3D1 IS  B IF 3D1 IS  C IF 3D1B I  D IF 3D1B I	Y QUALIFICATION ENERGY CALC (  = OR > 3C G  < 3C CALC  S = > 1 GO T  S < 1 PROJECT	ON TEST 2F5 X .33) O TO ITEM 4 SIR = (2F5+3 O ITEM 4 DOES NOT QUE	\$ 22 BD1)/1E) 9. ALIFY	05. 60	
4. FIRST YEAR DOLLAR SA	VINGS 2F3+3A+	(3B1D/(YRS EC	CONOMIC LIFE	:))\$	1012.
5. TOTAL NET DISCOUNTED		5+3C)		\$	
6. DISCOUNTED SAVINGS F (IF < 1 PROJECT DOE	RATIO ES NOT QUALIFY	(SIR)=(5 /	/ 1E)= 13.	.51	
•		â		0.1	

.91

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4

### WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8 BUILDING 60

### Given:

# of people = 48 people -from field survey

Water heater efficiency = 70% -assumed

Gas cost = \$4.67 / MBtu -from utility rate analysis
Water Cost = \$2.39 / 1000 gals -from utility rate analysis

**Showers:** 

# of showers = 18 showers -from field survey
Existing water flow = 3.75 gpm -from field survey
Improved water flow = 1.6 gpm -from field survey

Usage = (7 min/person day)\*(365 days/year) = 2.555 min/person vr -assumed

= 2,555 min/person yr - assumedShower water temperature  $= 102^{\circ}F - \text{assumed}$ 

Supply water temperature = 66°F -from City of Atlanta info

Faucets:

# of faucets = 36 faucets -from field survey
Existing water flow = 2.25 gpm -from field survey
Improved water flow = 0.40 gpm -from field survey

Usage =  $(5 \text{ min/person day})^*(365 \text{ days/year})$ = 1,825 min/person yr -assumed

Faucet water temperature  $= 80^{\circ}F$  -assumed

Supply water temperature  $= 66^{\circ}F$  -from City of Atlanta info

### **Annual Existing Flow:**

Showers:

 $(48 \text{ people})^*(3.75 \text{ gpm})^*(2,555 \text{ min/yr}) = 459,900 \text{ gal/yr}$ 

Faucets:

 $(48 \text{ people})^*(2.25 \text{ gpm})^*(1,825 \text{ min/yr}) = 197,100 \text{ gal/yr}$ 

Total:

459,900 gal/yr + 197,100 gal/yr = 657,000 gal/yr

### **Annual Improved Flow:**

Showers:

(48 people)\*(1.6 gpm)\*(2,555 min/yr) = 196,224 gal/yr

Faucets:

 $(48 \text{ people})^*(0.40 \text{ gpm})^*(1,825 \text{ min/yr}) = 35,040 \text{ gal/yr}$ 

Total:

196,224 gal/yr + 35,040 gal/yr = 231,264 gal/yr

### **Annual Non-Energy Savings:**

Showers: 459,900 gal/yr - 196,224 gal/yr = 263,676 gal/yr197,100 gal/yr - 35,040 gal/yr = 162,060 gal/yr395W. Total: 657,000 gal/yr - 231,264 gal/yr = 425,736 gal/yrRidova li 🐐 THERE REPORTS **Annual Energy Savings:** Secretary Wiler Coat Showers: (263,676 gal/yr)\*(8.33 lbs/gal)\*(1 Btu/lb °F)\*(102°F - 66°F)/70% 18159 1 15 TO = 113.0 MBtu/yror only to the Faucets: कराज्य हुलांस्य ह (162,060 gal/yr)\*(8.33 lbs/gal)\*(1 Btu/lb °F)\*(80°F - 66°F)/70% The Commonly = 27.0 MBtu/yr7388, × Total: 113 MBtu/yr + 27 MBtu/yr = 140 MBtu/yr . १८ % १<del>५% वर्ष</del> The property of **Annual Cost Savings** ratant ji (\$4.67/MBtu)\*(140 MBtu/yr) + (\$2.39/1000 gal)\*(425,736 gal/yr) = \$1,671/yrImproved water time **Estimated Construction Cost:** Speau -from engineer's cost estimate \$31.74/shower Faucht winer temp -from engineer's cost estimate \$17.36/faucet Supply water - c (\$31.74/ea)\*(18 showers) + (\$17.36/ea)\*(36 faucets) ecoust Existing Clove = \$1,196lanswry: S \$1,196 + (\$1,196 \* .055 SIOH) + (\$1,196 \* .06 DESIGN) = \$1,334 El\*(sinoeq 84) 1835112.1 h (1.12)\*(eliq-ser; 36) dato" 459 900 get e - . Annual Improved Page 1815WO: 1 (48 pt option) ( Faucetst - My talgoad 8M :lator 196,224 ual/yr - - -

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 8 - Water Flow Restrictors

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

FILE: ECO-8.WK3
PREPARED BY: R. GERRANS
CHECKED BY: EMC PROJECT: #3105.000 DATE: 15-Jul-92

	ENERGY	DISCOUNT
	COST	FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / KWh	11.11 UPWE
Demand Savings	\$8.85 / KW	10.59 UPW
Water Savings	\$2.910 / 1000 gals	10.59 UPW

Economic Life: 15 yrs

BLDG#	PEAK DEMAND SAVINGS (KW)	BLDG # DEMAND ELECTRIC G SAVINGS SAVINGS SAV (kW) (kWh/vr) (MB	ANNUAL GAS SAVINGS S (MBtu/vr) (1	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON- ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
G935		0	66	1L	JI I	\$0	\$550		\$425	29.4	4.0
Include \$5(	ude \$500 cost for adr	dministation of sma	of small contract	ract					\$500		
TOTAL	0	0	66	66	\$460	<b>8</b>	\$550	\$550 \$1,010	\$925	13.5	6.0

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM

ECO: 8 - WATER FLOW RESTRICTORS

PREPARED BY: CHRIS STANLEY

CHECKED BY:

EMC PROJECT: #3105.000

DATE: 22-APR-92

FILE: ECO8.WK3

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS:

\$2.910 / 1000 gals WATER

USAGE / YEAR min/yr) SHOWER SUPPLY FAUCETS 99 WATER TEMP 102 IMPRVD (gal/yr) FLOW SHOWER FLOW RESTRICTORS FLOW (gal/yr) 1.50 IMPRVD FLOW (mdb) 4.50 (mdb) FLOW /YEAR min/yr) USAGE SHOWERS ဓ PEOPLE BLDG 935 #

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ECC. 3 - Mater Flow Resmotors

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THE STATE OF THE 31 - H. 1000 1111 ENC PROM TX

Same Contraction

4 CENOMIC CHECK AND TO

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY LOCATION: FORT GILLEM ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91-C-0097 CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS: WATER \$2.910 / 1000 gals

FILE: ECO8.WK3
PREPARED BY: CHRIS STANLEY
CHECKED BY: EMC PROJECT: #3105.000 DATE: 22-APR-92

CHASURTY 1045

	=	=				'n		
	1401		L	200	છ	н	\$38 8	
200	110::		1 600	200	(8/83)		\$17.36	
<u>ر</u>			1000	COSI	(6/03)	100	\$31.74	
				SAVED	(C/) (L)		\$550	
		CLIFAIN	ביו בא	SAVED	(20)100)	(dal/yl)	229.950	1
CAVINGS		4	GAS	SAVED		(MBIU/VI)	98.5	
	_	4	_	HEATER		1	7002	2
				A iddi is	- i	Œ		
			WATER TEMP	TALICET	ב ב ב	Œ.		
000			MPRVD	30	21.	(nal/vr)		
			EXIST		Z 2 2	(מאוליבט)	7.17.15.51	
			IMPRVD	i	7 2 2	(200)	7111251	
		-	TSIXE	i	¥ 2,1	(mus)	III.dF	
II			١				IL	اللمت

### APPENDIX D-4 NAF PROJECTS

ECO-14, LOADING DOCK SEALS ECO-14, RADIANT HEATERS ECO-18, REPLACE IXIT SIGN BULBS WITH FLUORESCENT BLUB KITS

CHECKED BINEBARREL - V. CHALLY STAMELY
HITELECON TAUT
DALE: \$5 + 14 - 85
EWO BROTHLY - NATRE 900

CHEUL BROSTOL BAR JEINE STRONGS.

ECO: B - MALEB ELOM GEALMOLOGG FOCKHOM LOGI, GIFTIN BROTECH FOIL WASHEBSON & LOGI, GIFTEW ESOR FINDA

OR CHURCHES SAL

শ্বশ্বর প্রত্যা বিশ্ববাদ বিভাগন বিশ্ববাদ বিশ্ববাদ বিশ্ববাদ বিশ্ববাদ বিশ্ববাদ প্রকাশ বিশ্ববাদ বিশ্ববা 1 .01912. #023 1100 Missif Bent Wall TESTON TO THE STONE OF THE STON 1 IRIK . 1997 (1886) 1997 (1998) เริ่มกระเริ่ม s () 4 (1384) · · · .81 à. T. .... . 252 \$ (**\$6**\$ (\*\*\*\*) . \*\*\*\* .328 decreases where the state of th ¥ . \$ : 13% ... will be a second

42 / 100

\$6.4 × 5.46

22462. 496520.

	LIFE CYCLE COS ENERGY CONSERVATION STALLATION & LOCATION:	ST ANALYSIS SU	IMMAL	KY NAME (EGID)	STUDI:	GNA	Ar 065
T 3.7.	ENERGY CONSERVATION	A THAFSIMENI P	RUGE	CAM (ECIP	A CENSUS.	3 .	.065
TMS	DJECT NO. & TITLE: DAG	77. GILLEM,	NARE	RETON NOS	TINCE OPPOP	J TINIT	עיבעומוס עיו
PK	SCAL YEAR 1992 DISC	NST-2T-C-0021	אר אינו אר או	NEKGI DA	TECTS	OHI	II SORVEI
	ALYSIS DATE: 09-02-92					KC	
WIAT	ALISIS DATE: 09-02-92	ECONOMIC LI	LPE 2	CARGI C	REFERENCE DI.	110	
1	INVESTMENT				,		
Τ.		7				\$	103512.
	P STON	•				\$ \$ \$	5694
	C DESIGN COST					Š	6211.
	D SALVAGE VALUE COS	ያጥ				-\$	0.
	A. CONSTRUCTION COST B. SIOH C. DESIGN COST D. SALVAGE VALUE COSE. TOTAL INVESTMENT	(1A + 1B + 1C)	2 - 1	(מ		Š	115417.
	E. IOIIM INVESTIBILE	(		,		•	
2.	ENERGY SAVINGS (+) /	COST (-)					
	ANALYSIS DATE ANNUAL	SAVINGS, UNI	T CC	ST & DISC	COUNTED SAVI	NGS	
	UNIT COST FUEL \$/MBTU(1)	SAVINGS	ANN	UAL \$	DISCOUNT	DIS	SCOUNTED
	FUEL \$/MBTU(1)	MBTU/YR(2)	SAV	/INGS(3)	FACTOR (4)	SAV	VINGS(5)
	A. ELECT \$ 7.47	611.	\$	4562.	15.61		71217.
	B. DIST \$ .00	0.	\$	0.	21.66		0.
	C. RESID \$ .00	0.	\$	0.	26.51		0.
	D. NAT G \$ 4.67	3829.	\$	17881.	23.77		425042.
	A. ELECT \$ 7.47 B. DIST \$ .00 C. RESID \$ .00 D. NAT G \$ 4.67 E. COAL \$ .00	0.	\$	0.	16.06		0.
				00444		*	406050
	F. TOTAL	4440.	\$	22444.		Þ	490239.
_	NON ENERGY SAVINGS(+)	/ COST(-)					
3.							
	A. ANNUAL RECURRING (1) DISCOUNT FACT (2) DISCOUNTED SA	(+/-)			*	\$	18.
	(1) DISCOUNT FACT	OR (TABLE A)			14.53	•	
	(2) DISCOUNTED SA	AVING/COST (3)	A X 3	3A1)		\$	262.
	C. TOTAL NON ENERGY I	DISCOUNTED SAV	/INGS	S(+)/COST	(-) (3A2+3Bd4	:)\$	262.
	D. PROJECT NON ENERGY	QUALIFICATION	ON TH	EST			
	(1) 25% MAX NON I	ENERGY CALC (2	2F5 2	( .33)	<b>\$</b> 16376	5.	
	A IF 3D1 IS	= OR $>$ 3C GG	OT C	ITEM 4			
	B IF 3D1 IS	< 3C CALC	SIR	= (2F5+31)	D1)/1E)	_	
		S = > 1 GO TO					
	D IF 3D1B IS	S < 1 PROJECT	DOES	S NOT QUA	LIFY		
				. / /	ONONTO TIBE!	\ <b>#</b>	22462
4.	FIRST YEAR DOLLAR SAV	VINGS 2F3+3A+	(3811	)/(YRS EC	ONOWIC LIFE)	) Þ	22402.
_		0311TNGQ /0TF	. 201				496520
5.	TOTAL NET DISCOUNTED	SAVINGS (2F5	+30)			₽	490520.
_	DISCOUNTED SAVINGS RA	N T C	10	STD1=/5 /	1E)= 4 3	ŧ0	
٥.	(IF < 1 PROJECT DOE:	S NOW CHIMILER	, (;	211/-(2 /	TE) - 4.3		
	•						
7.	SIMPLE PAYBACK PERIOR	(ESTIMATED)		SPB=1E/4	5.1	4	
		, ,		•			

STUDY: GNAF

LIFE CYCLE COST ANALYSIS SUMMARY ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

## E M°C ENGINEERSSINC.

PROJECT: PORT MEPHERSON & FORT GILLEM ESGS STUDY MY LOCATION FORT GILLEM

CLIENT CONTRACTINO: DACA21-91-C-0097

EMG-RRG-JEGT: #3105,000 DATE: 02-3005-92 FILE: ENLINAE WK3
PREPARED BY: CMD
CHECKED BY: CEL

AMNIIAI			TYNNY	
10.59 UPW	14.53 UPW	\$8.85 / kW		Demand Savings
11.13 UPWE	15.61. UPWE	\$0.0255 / kWh		Electric Savings
14.45 UP(4G	23.77 UPWG	\$4.67 / MBtu		Gas Savings
FACTOR	FAGTOR	∴1\$OO		
12-XP DISCOUNT	25-YR DISCOUNT	ENERGY		

			ANNUAL						AMMIAI				
			PEAK	ANNUAL	ANNUAL	TOTAL	ANNUAL	ANNUAL	NON	TOTAL			
# CO	ECONOMIC BUILDING	BUILDING	DEMAND	ELECTRIC	GAS	ENERGY	ENERGY	DEMAND	ENERGY	AMNOAL	CONST	SIB	SIMPLE
	H. (8.78)	NUMBER	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	SAVINGS	COST		PAYBACK
ECO-14 SEALS		505			]	l	\$2,151	08	0\$	\$2 151	£10 811	ac	(Vrs)
	15	506					\$2.151	80	08	\$2 151	\$10,811	0.7	0.0
	15	202	0	10,534			\$2,151	\$0	0\$	\$2.151	\$10,811	2.8	5.0
	15		0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15		0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	510	0	10,534	403	439	\$2,151	0\$	\$0	\$2,151	\$10,811	2.8	5.0
	15	511	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15		0	10,534	403	439	\$2,151	0\$	\$0	\$2,151	\$10,811	2.8	5.0
	15		0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	514	0	10,534	403	439	\$2,151	\$0	0\$	\$2,151	\$10,811	2.8	5.0
	15	214	0	5,267	202	220	\$1,078	80	\$0	\$1,078	\$5,406	2.8	5.0
SUBIOTAL			0	100,073	3,82	4,170	\$20,433	20	C\$	\$20,433	\$102,705	4.5	5.0
ECO-18	25		-	7,884		27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25		-	7,884		27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25		-	7,884		22	\$201	\$92	(16\$)	\$203	\$1,271	2.5	6.3
	25	į	-	7,884		22	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25		-	7,884	C	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25			7,884	0	22	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25		-	7,884	0	22	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25		-	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	513	-	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	514	-	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1.271	2.5	6.3
SUBTOTAL			6	78,840	0	593	\$2,010	\$924	(906\$)	\$2,028	\$12,711	2.5	6.3
TOTAL			0	178,913	3.829	4,439	\$22,444	\$924	(\$908)	\$22.462	\$115.418	43	u,
												1000	

SEE APPENDIX C FOR ADDITIONAL CALCULATIONS